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MAGNETIC FIELD MEASUREMENTS AT JUPITER BY VOYAGERS 1 AND 2: DAILY PLOTS OF 48 SECOND AVERAGES

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Goddard Space Flight Center
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MAGNETIC FIELD MEASUREMENTS AT JUPITER BY VOYAGERS 1 AND 2:
DAILY PLOTS OF 48 SECOND AVERAGES

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Abstract

This document provides a series of 24-hour summary plots of the magnetic field, in 48-s average form, measured in the vicinity of Jupiter by the magnetometers onboard Voyagers 1 and 2. The Voyager 1 data cover the period from 27 February 1979 (Day = 58) to 23 March (Day = 82) inclusive, and the Voyager 2 data cover the period from 2 July 1979 (Day = 183) to 14 August (Day = 226) inclusive. Closest approach to the planet occurred on days 64 (AT 1205 UT) and 190 (AT 2230 UT) for Voyagers 1 and 2, respectively. Also included in this document are: a description of the characteristics of the magnetometers, a brief description of the near-planet trajectories of the two spacecraft, a listing of the bow shock and magnetopause crossing times, and a bibliography containing Voyager-Jupiter related papers and reports whose authors are members of the Voyager magnetometer team.

Introduction, Experiment Description, and Near Jupiter Trajectories

The Voyager magnetic field experiment consists of dual low field (LFM) and high field (HFM) triaxial fluxgate magnetometer sensors and associated electronics with extensive redundancy for high reliability as well as for use in correcting for the spacecraft's magnetic field. One LFM is located at the tip of a 13-m boom; the other is mounted 5.6 m inboard. The total weight of the sensors plus electronics, including the two HFM instruments, is 5.6 kg, and the power required is 2.2 W. During Voyager 1 Jupiter encounter, the LFM's automatically ranged through seven (of eight possible) scales for maximum sensitivity (± 8.8 nanoteslas (nT) to ± 6400 nT, with quantization steps of 0.0044 nT to 3.12 nT). During Voyager 2 encounter, the LFM's ranged through five of these scales. The sensor equivalent root-mean-square (rms) noise is 0.006 nT (0.01 to 8.3 Hz). The dual magnetometer method (see Ness et al., 1971, for a description) and the estimation of zero offsets yielded an accuracy of ± 0.2 nT ± 0.1 percent of full scale. The vector field was measured every 60 msec, and averages over 48 s are presented in this report in plot form. A more complete description of the experiment and its planned role in the Voyager mission is given by Behannon et al. (1977).

The Voyager magnetometer team consists of Mario H. Acuña, Kenneth W. Behannon, Leonard F. Burlaga, John E. P. Connerney, Ronald P. Lepping, and Norman F. Ness (Principal Investigator) of the Laboratory for Extraterrestrial Physics, NASA/Goddard Space Flight Center, and Fritz M. Neubauer of the Technische Universität, Braunschweig, Federal Republic of Germany.

Figure 1 shows the Voyager 1 and 2 trajectories in the vicinity of Jupiter projected onto the Jupiter orbital plane. Also given are closest approach (CA) days and distances in Day of Calendar Year (DCY) and in Jupiter radii ($R_J = 71,372$ km), which are also used for the coordinate units. The model bow shock for the Voyager 1 encounter (BS(V1)) and the model magnetopause boundaries for both encounters (MP(V1) and MP(V2)) are also given. The BS and MP model boundaries are discussed by Lepping et al. (1981a) and are based on the observed boundary crossing times given in Table 1. Examples of some BS and MP crossing positions are shown in the figure. Other aspects of the Voyager-Jupiter trajectories, as well as the Voyager heliocentric trajectories, are discussed by Stone (1977).

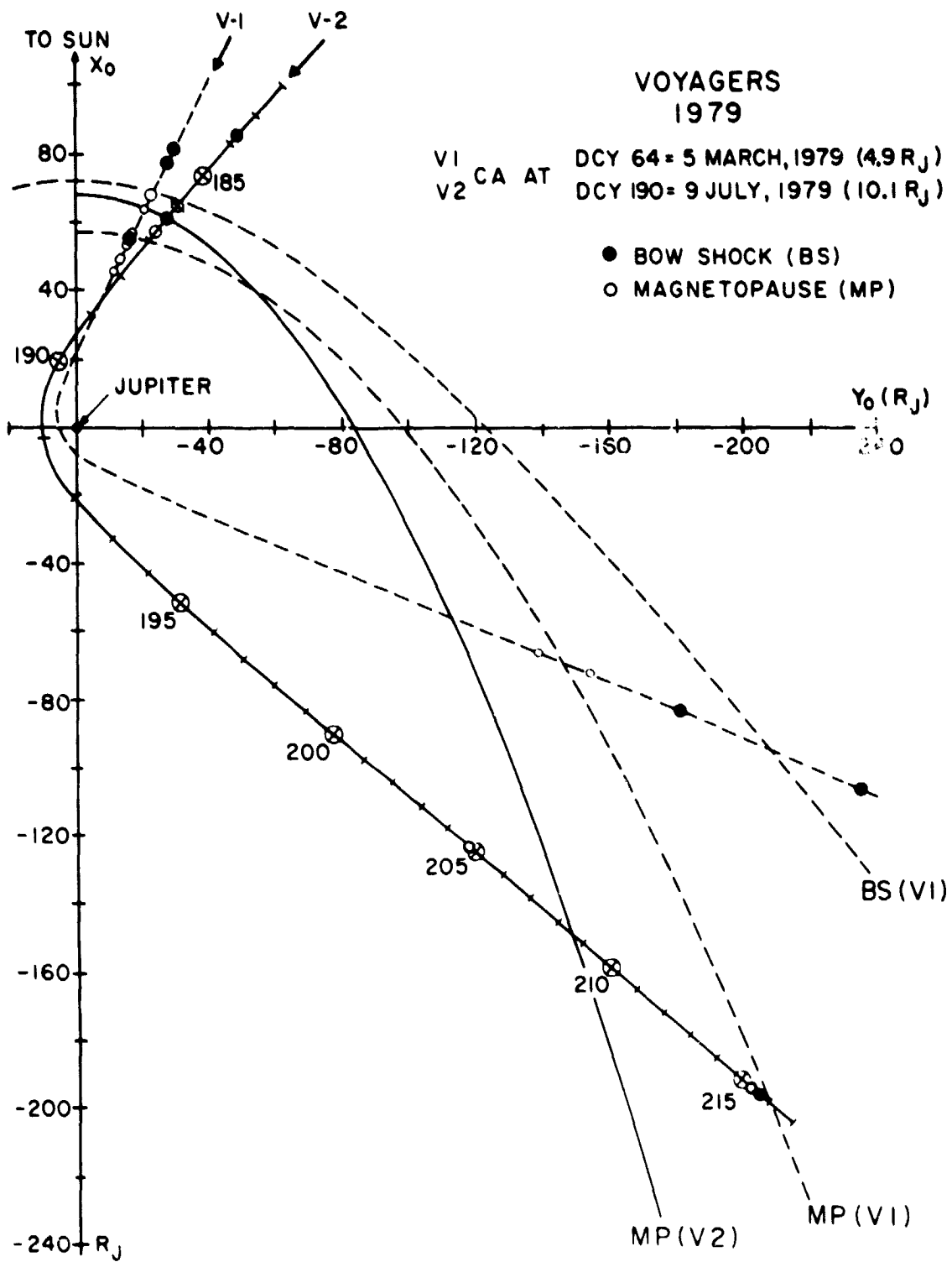


FIGURE 1

TABLE 1

VOYAGER MAGNETOPAUSE AND BOW SHOCK BOUNDARIES

VOYAGER 1			VOYAGER 2					
TYPE	DAY †	HOURS, MINUTES †	TYPE	DAY †	HOURS, MINUTES †	TYPE	DAY †	HOURS, MINUTES †
BS	59	1434	BS	183	1621	MP	212/213	1733-0605**
BS	59	1954	BS	183	1623	MP	213	1517
BS	60	1227	BS	183	1645	MP	213	1539-1602**
MP	60	1956	BS	183	1925	MP	214	0222
MP	61	0754	BS	184	1736	MP	214	0722
BS	61	0950	MP	185	2337	MP	215	0611
BS	61	1308	MP	186	0110	MP	215	0723 ?
MP*	61	1430	BS	186	0522	MP	215	0728 ?
MP*	61	2003	BS	186	0955	MP	215	0757
MP*	61	2045	MP	186	1840	BS	215	1441
MP*	61	2112	MP	204	1522-2340**	BS	215	1625
MP*	61	2153	MP	205	0135	BS	215	1703
MP*	61	2228	MP	205	0531	BS	216	0300
MP	62	0227	MP	205	0557	BS	217	0940
MP	74	0930	MP	205	0917	BS	217	1825
MP	74	1700	MP	206	0052	BS	225	0508-1254**
MP	74	2119	MP	206	0410	BS	225	141'
BS	77	0706	MP	208	1820	BS	225	1809
BS	79	0808						
BS	79	0827						
BS	80	0738						
BS	80	2107						
BS	81	0941						
BS	81	1303						

† DAY refers to day of year 1979 where 1 January = 1, and time is given in spacecraft UT.

* Identifications of these MP crossings are in doubt.

** Gap in data.

The Magnetic Field Data

In the 24-hour plots of the 48-s averages of the magnetic field, given at the end of this report, the field is represented in terms of its magnitude (F), longitude (λ = LAMDA), and latitude (δ = DELTA) in a spacecraft centered heliographic coordinate system. Also given is the pythagorean root-mean-square deviation (RMS). The magnitude F is based on an average of the magnitudes of the vectors occurring over the 48-second average, i.e.,

$$F = \frac{1}{N} \sum_{i=1}^N f_i,$$

where N is the number of vector measurements in 48 seconds and f_i is the magnitude of the i-th vector; the measurement period was 60 msec. RMS is defined as

$$RMS = [RMS_R^2 + RMS_T^2 + RMS_N^2]^{1/2},$$

where RMS_R is the root-mean-square-deviation of the R-th components of the vectors in the 48-s interval and likewise for the T and N components; the R, T, N components are defined below. F and RMS are rendered in units of nanotesla ($nT = 10^{-5}$ Gauss = γ). A description of the heliographic coordinate system and the definitions of λ and δ are given below. F and RMS are plotted on logarithmic scales where RMS always spans 0.01 to 10 nT, but where F spans either 0.1 to 10 nT (10 to 1,000 nT when folded) or 0.5 to 50 nT (50 to 5,000 nT when folded). Folded data are clearly labeled on the plots. The tick marks on the horizontal scale denote hours in spacecraft universal time.

The Heliographic Coordinate System

The heliographic coordinate system is defined by the spacecraft centered R, T, N coordinates, whose unit vectors are:

\hat{R} , along the sun-spacecraft line, positive away from the sun;

\hat{T} , perpendicular to \hat{R} and parallel to the sun's equator plane, positive in the sense of Jupiter's motion;

and

\hat{N} , equal to $\hat{R} \times \hat{T}$.

In angular representation the field is given in terms of:

its latitude, $\delta \equiv \sin^{-1} (\langle B_N \rangle / \langle B \rangle)$

and its longitude, $\lambda \equiv \tan^{-1} (\langle B_T \rangle / \langle B_R \rangle)$,

where

$$\langle B \rangle \equiv [\langle B_R \rangle^2 + \langle B_T \rangle^2 + \langle B_N \rangle^2]^{1/2},$$

and where the symbol $\langle \rangle$ represents an average (over 46 seconds in the case of the plots in this report). Note that $\langle B \rangle \leq F$, as defined above.

Outbound Voyager 2 Data Gaps/Quality

The long data gaps (often > 8 hours in duration) occurring in the late outbound Voyager 2 data set, i.e., days 220 through 226, were due indirectly to the fact that Earth and the spacecraft were close to superior conjunction with respect to the sun. Because of the superior conjunction, Deep Space Stations in Madrid, Spain temporarily discontinued tracking the spacecraft, resulting in the near daily periodicity of the larger data gaps over this period. Radio transmission through the sun's atmosphere obviously made spacecraft communication difficult for the remaining Deep Space Stations. Consequently, for the data that was collected data quality suffered over this period; this is especially evident for days 225 and 226.

Voyager - Jupiter Magnetic Field Data in NSSDC

The Voyager magnetic field data for the periods covered by this report have been submitted to the National Space Science Data Center (NSSDC), Goddard Space Flight Center, in the form of magnetic tapes. These so-called Summary Tapes contain vector data in both cartesian component and angular representa-

tion for the 48-s averages shown in this report, as well as for 1.92 and 9.6-s averages. Also separate tapes exist for two coordinate systems of interest: (1) Heliographic, used here, and (2) Jupiter System III (1965.0). Appropriate documentation accompanies these tapes.

Acknowledgments

We thank all of our colleagues who share in the various phases of this marvelous venture called Voyager; hardware, software, scientific, drafting, typing, and financial! We are especially grateful to Ken Behannon for helpful comments on the manuscript.

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VOYAGER 1

DAILY PLOTS OF 48-SEC MAGNETIC FIELD DATA

(27 February 1979 to 23 March, inclusive)

F, magnitude in nI

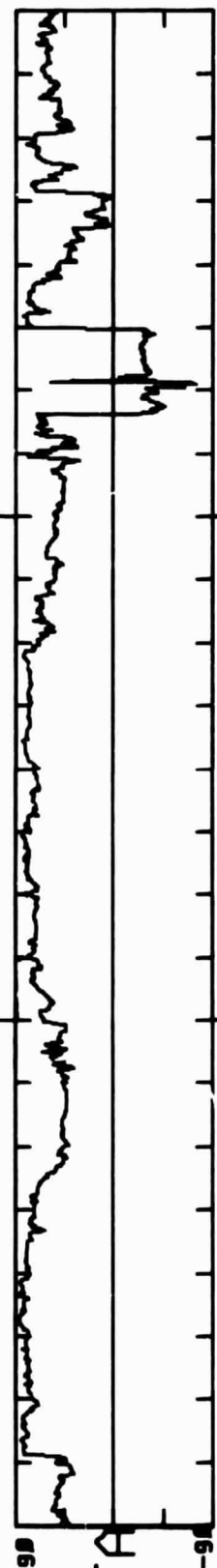
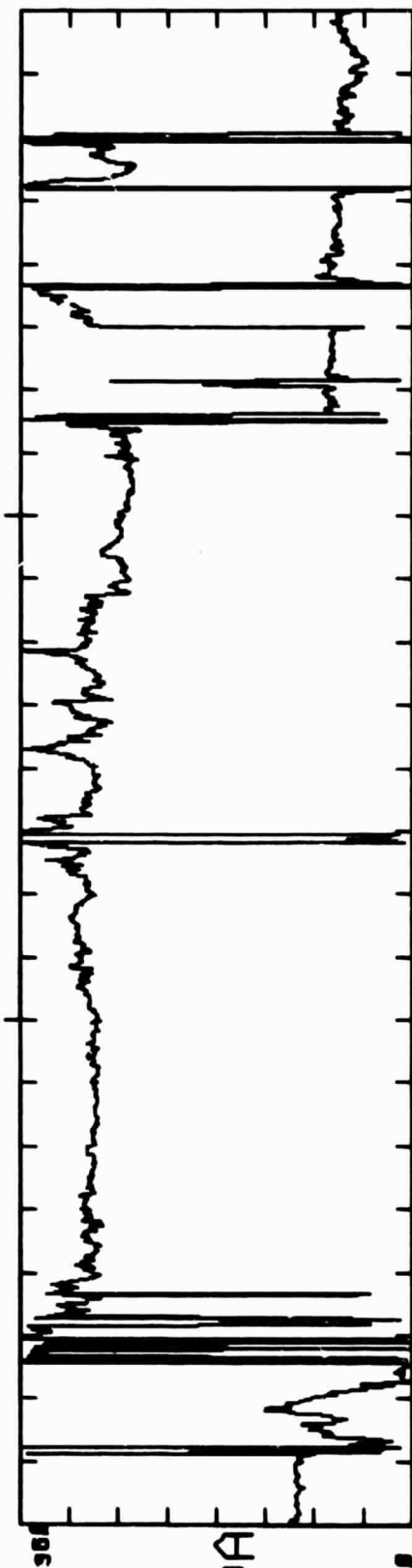
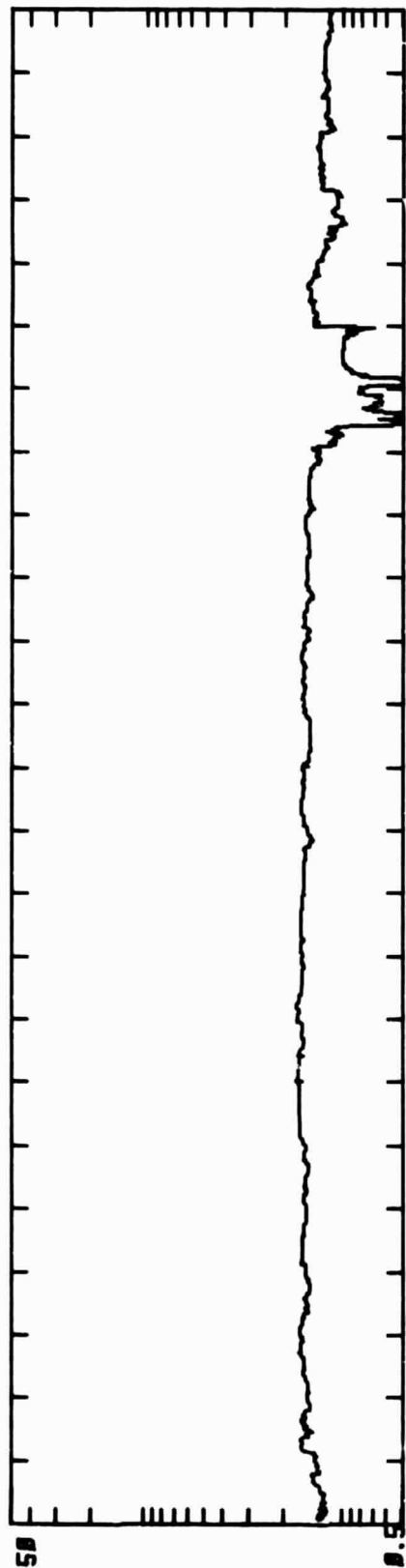
LAMDA, longitude

DELTA, latitude

RMS, pythagorean root-mean-square-deviation in nI

in heliographic coordinates; see text for definitions. Time is in spacecraft universal time and days are in calendar-day-of-year (DCY) such that Jan 1 = Day 1.

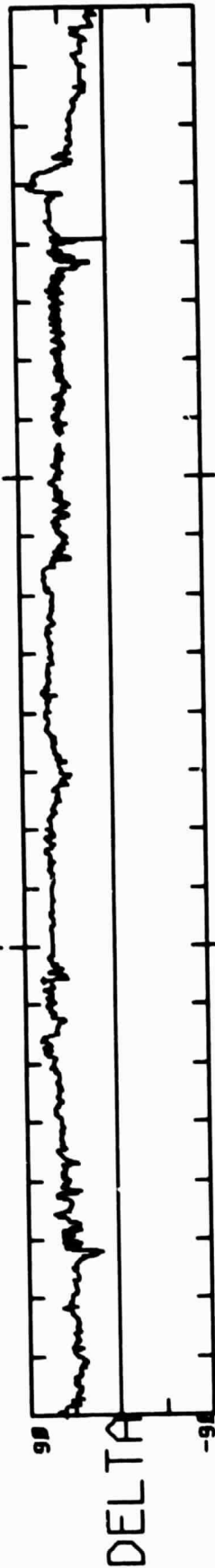
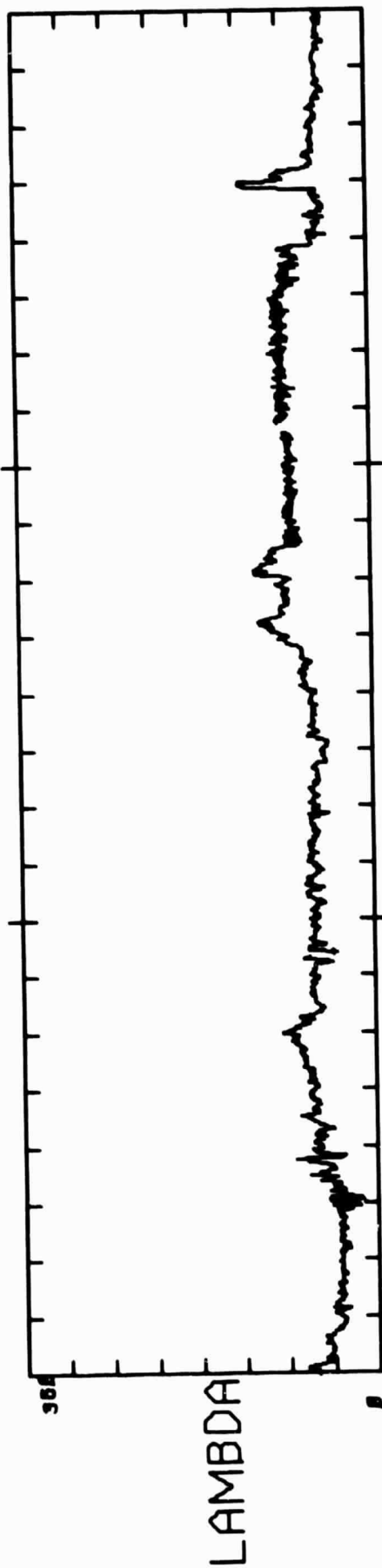
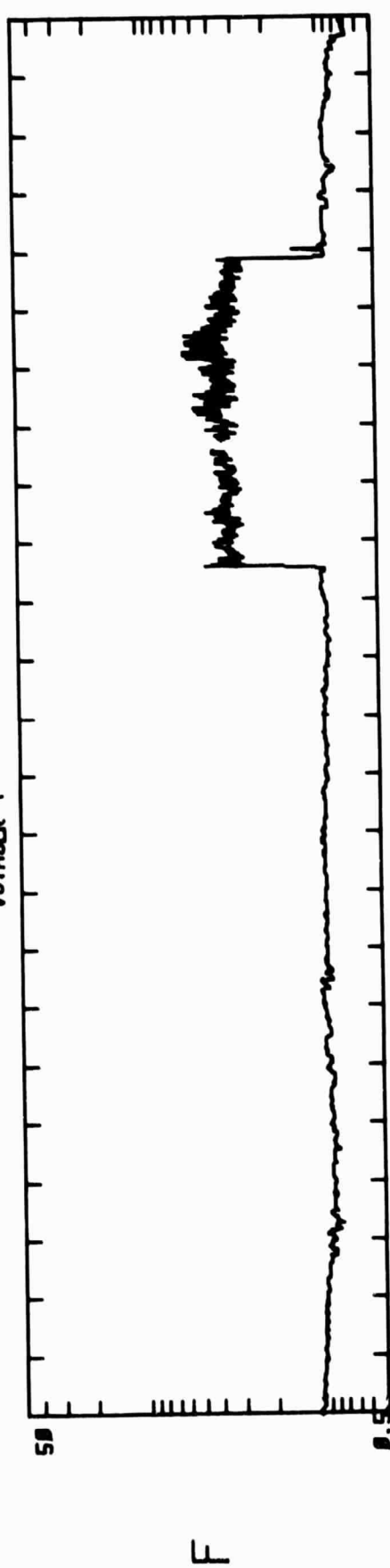
VOYAGER 1



START YEAR +DAY
79 58

27 February

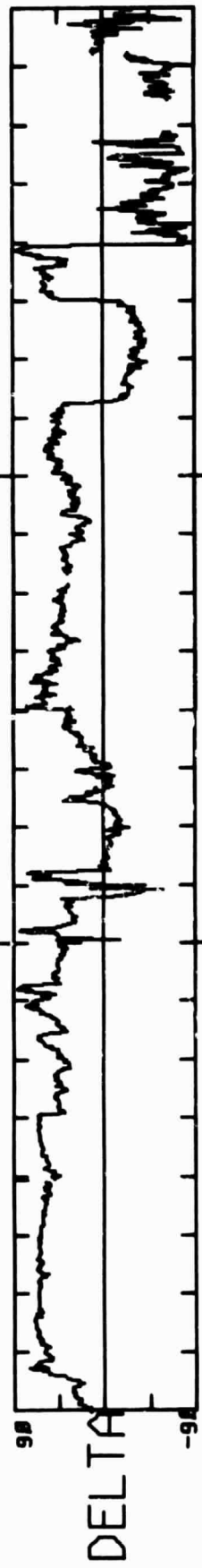
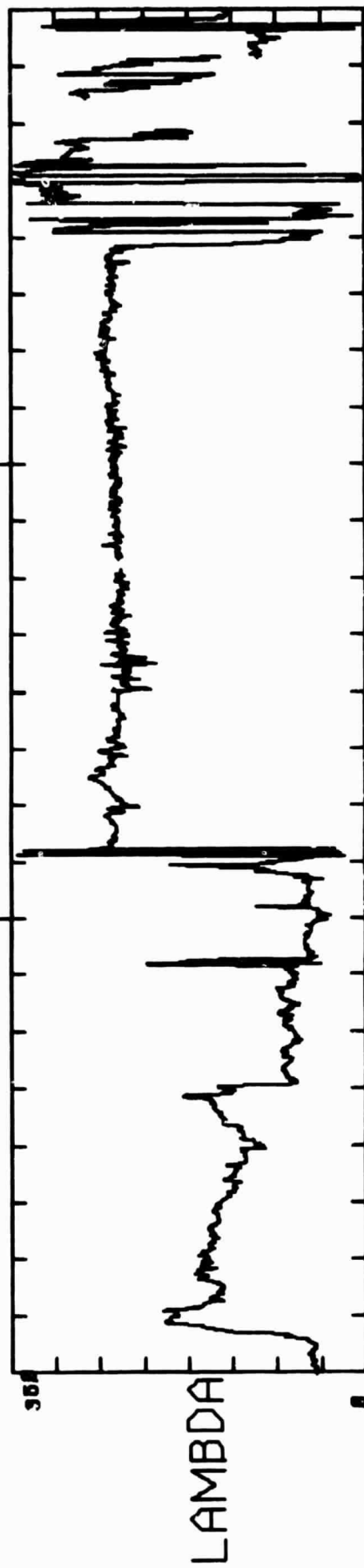
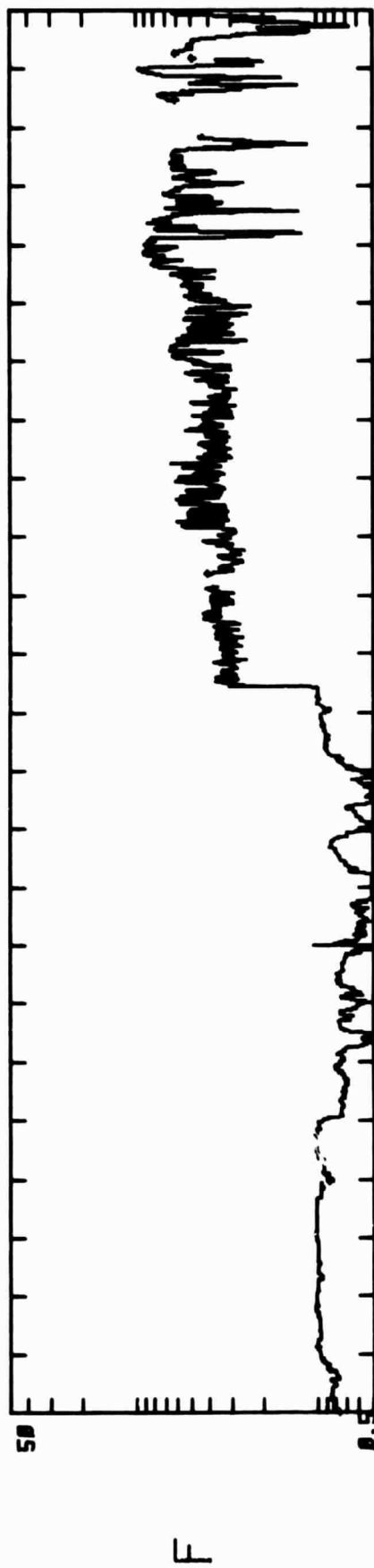
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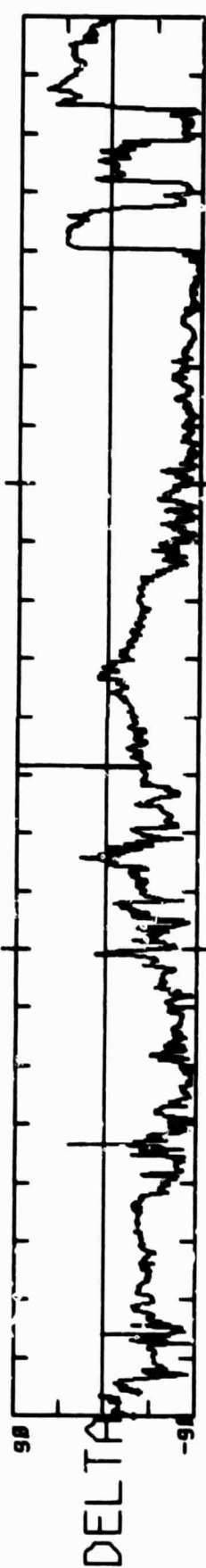
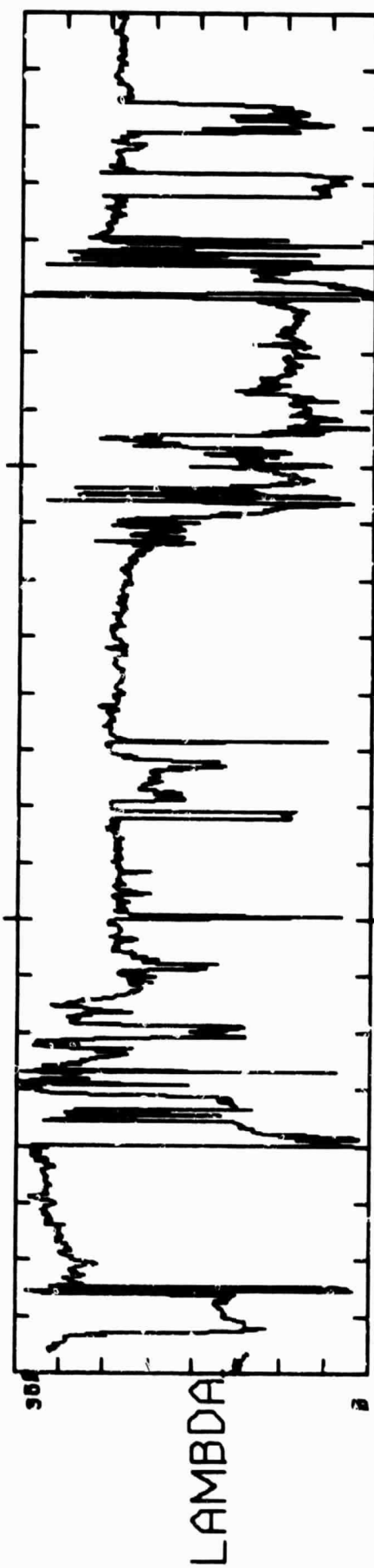
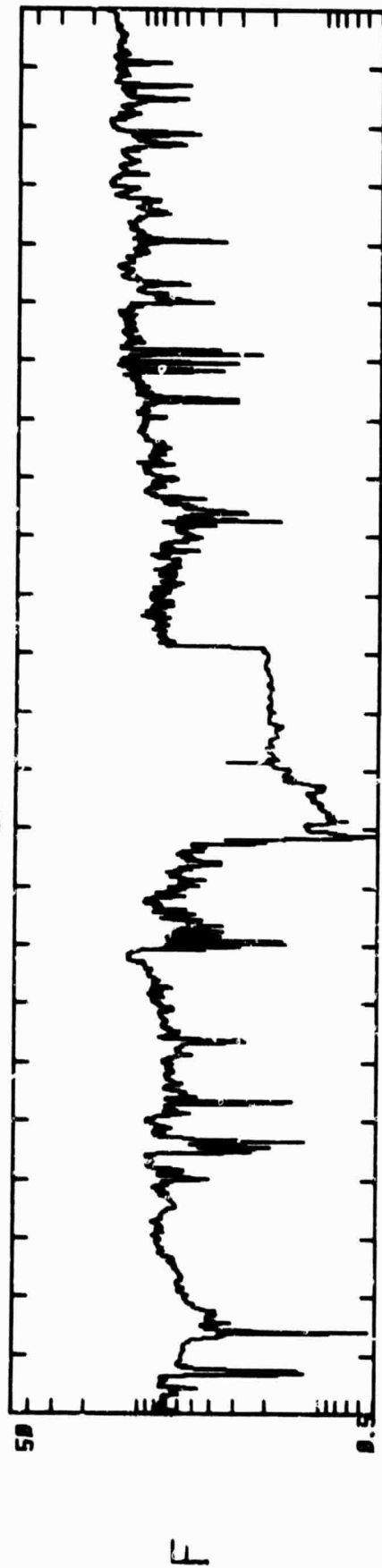
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START YEAR +DAY
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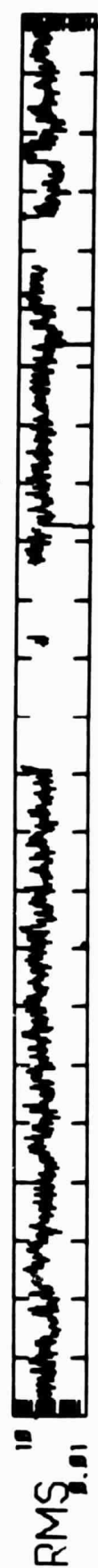
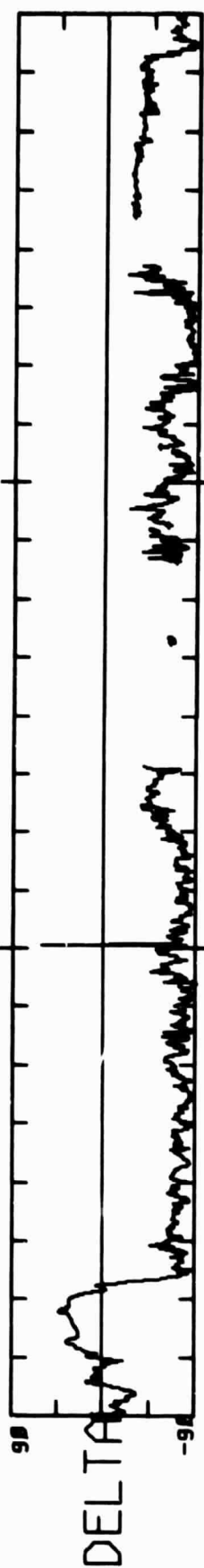
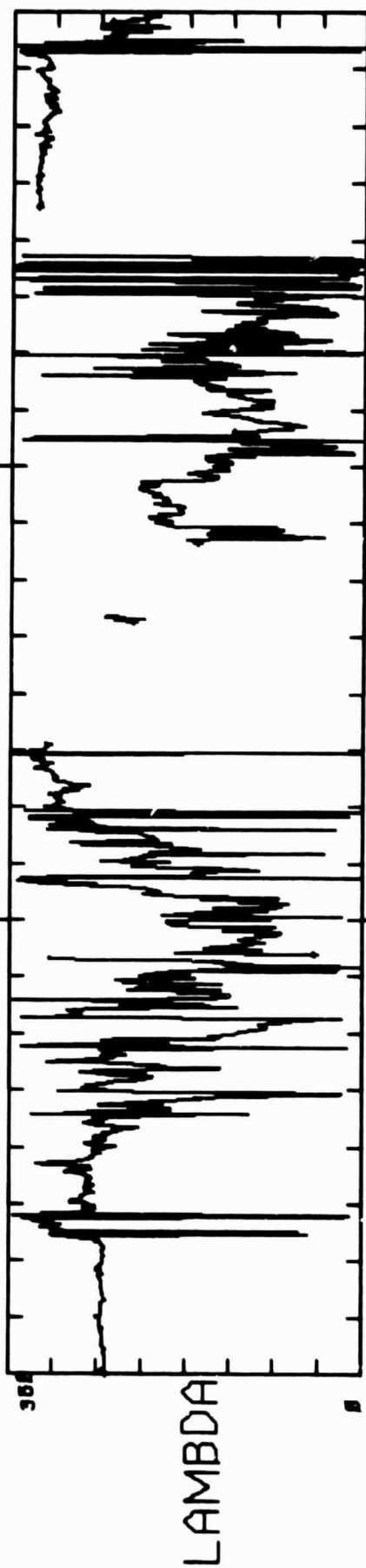
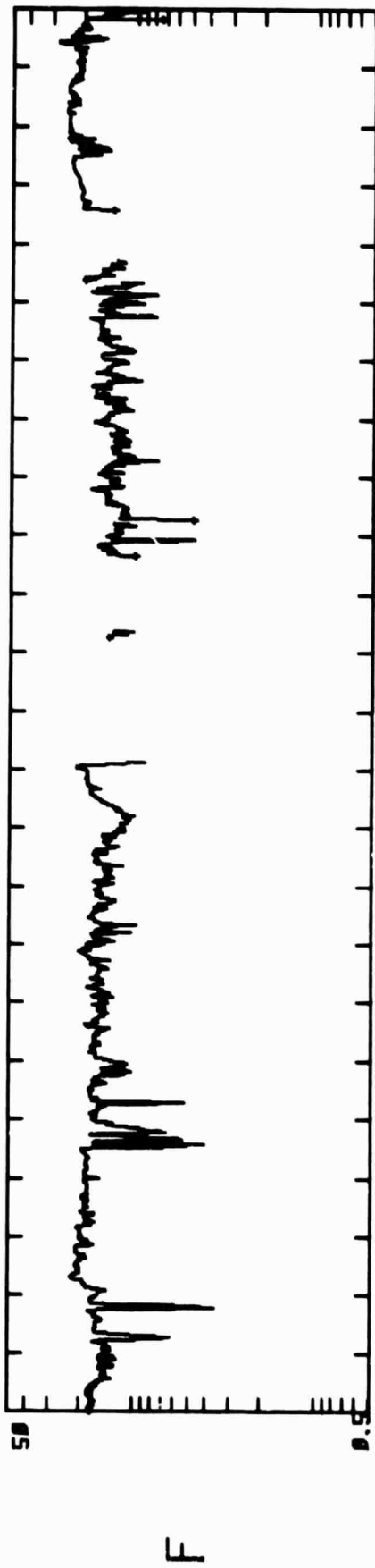
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START YEAR + DAY
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2 March

VOYAGER 1



START YEAR +DAY
79 62

3 March

VOYAGER 1

F

FOLDED

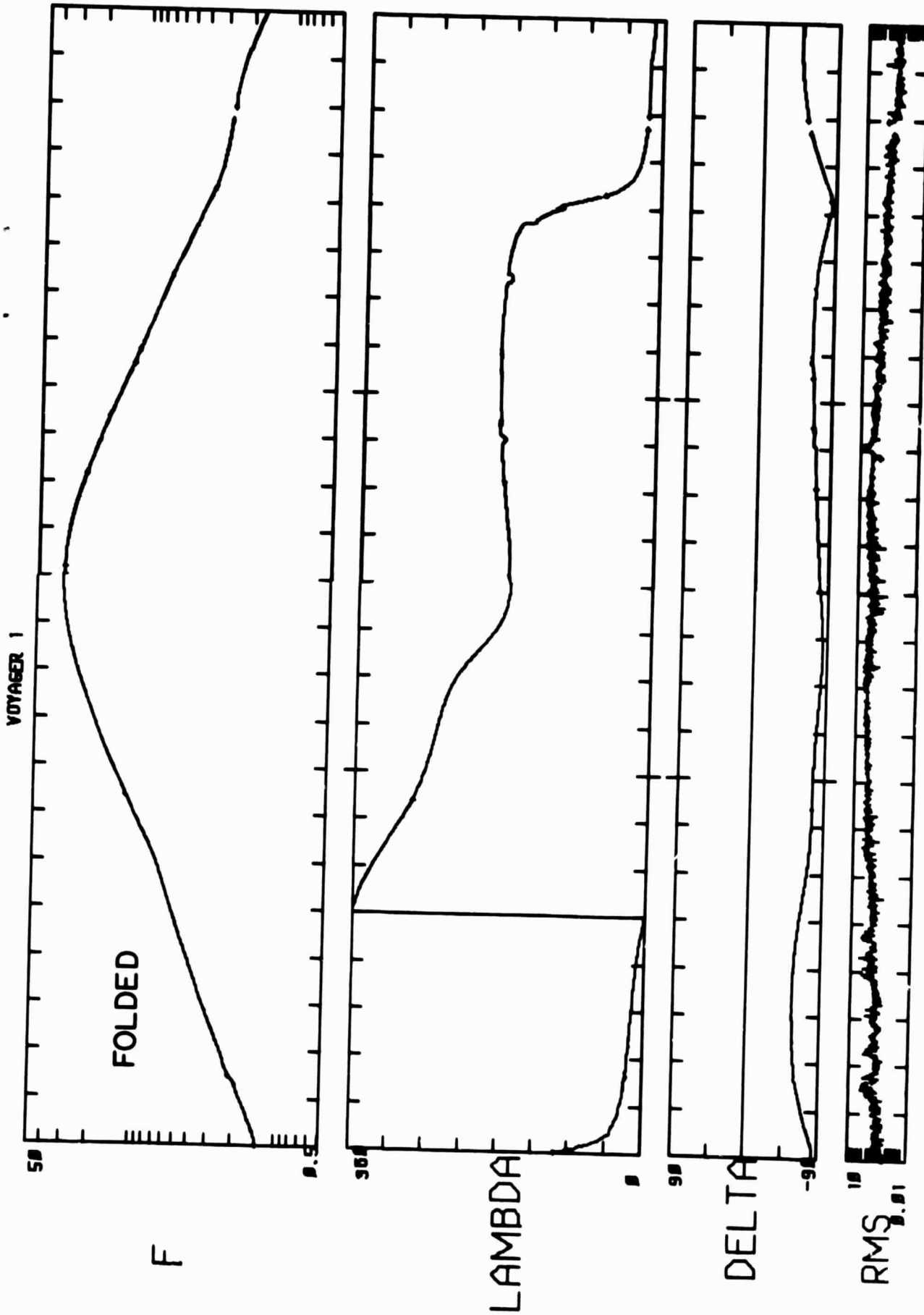
LAMBDA

DELTA

RMS

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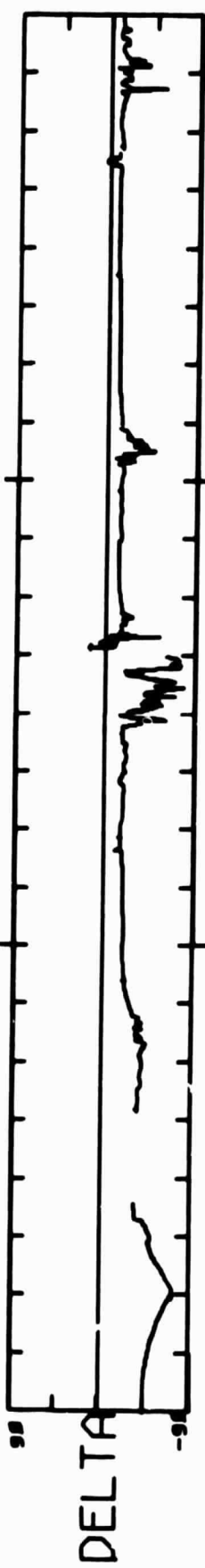
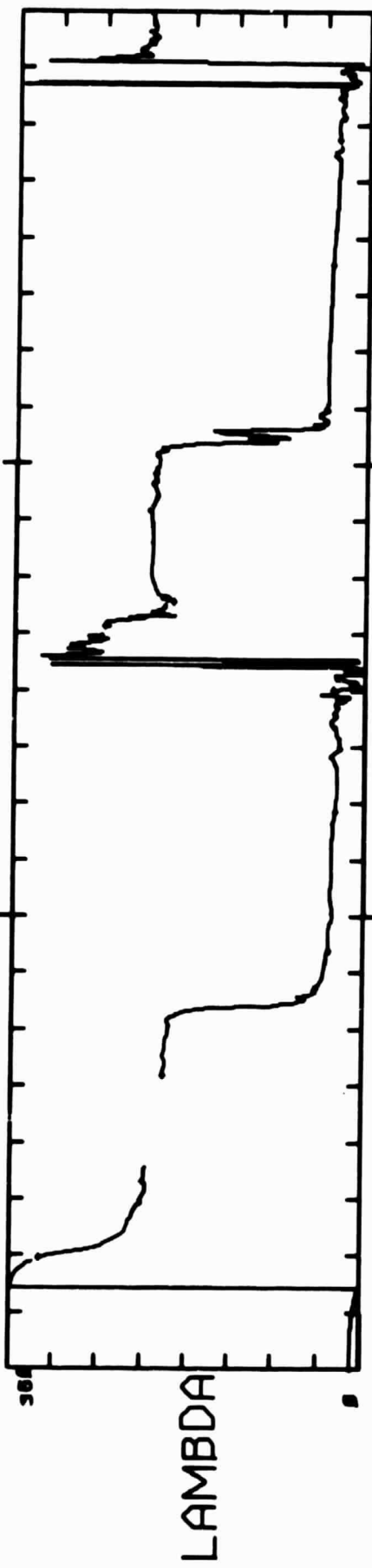
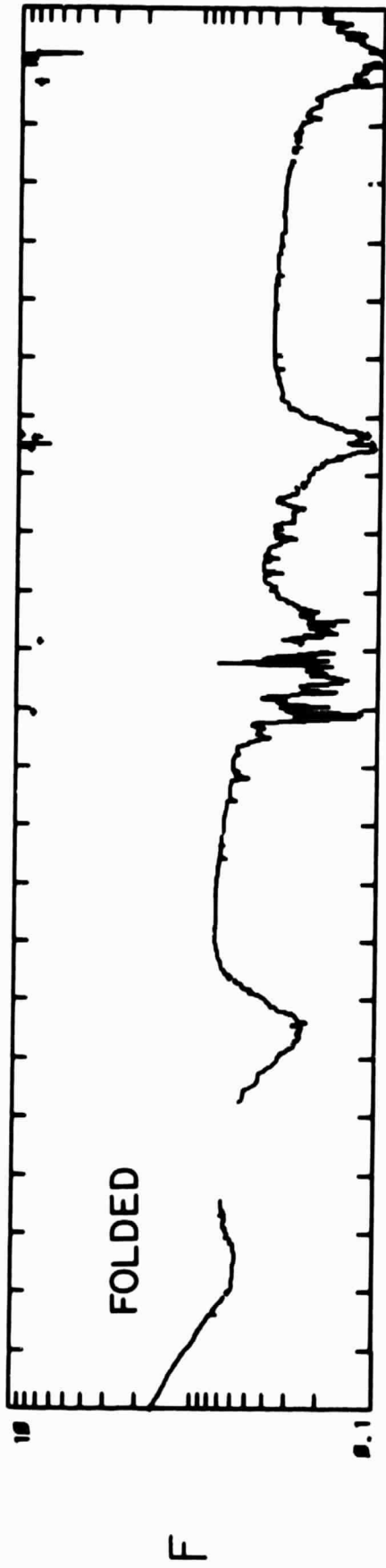
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5 March

NOTE SCALE CHANGE

VOTAGER 1



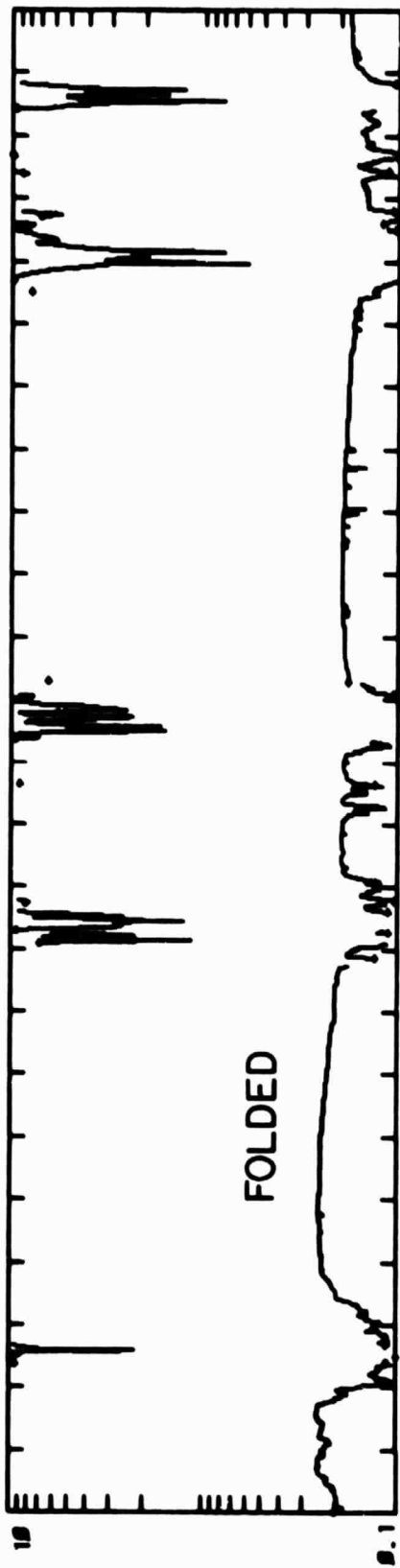
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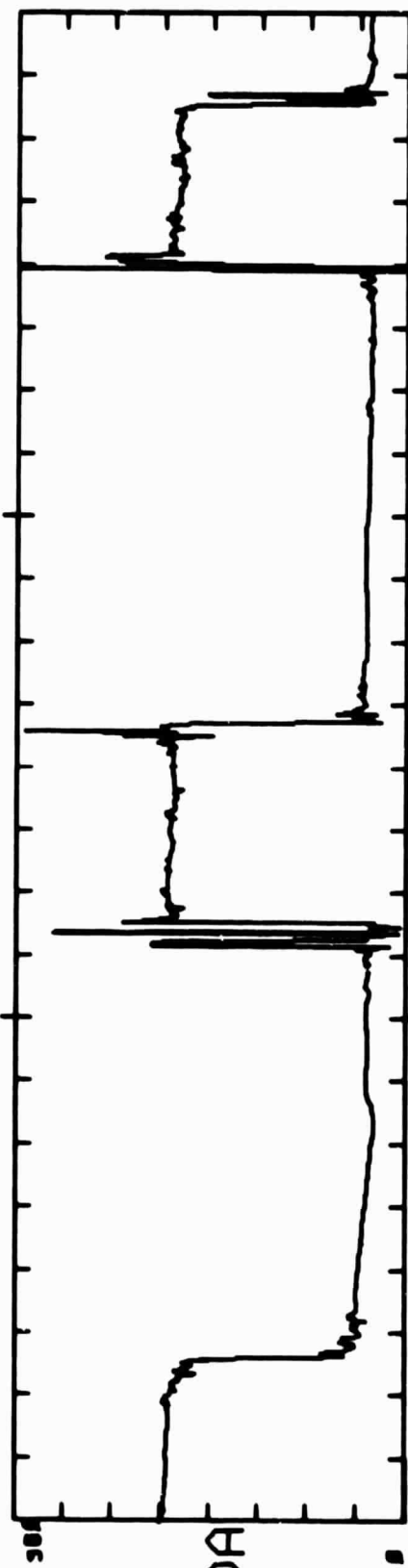
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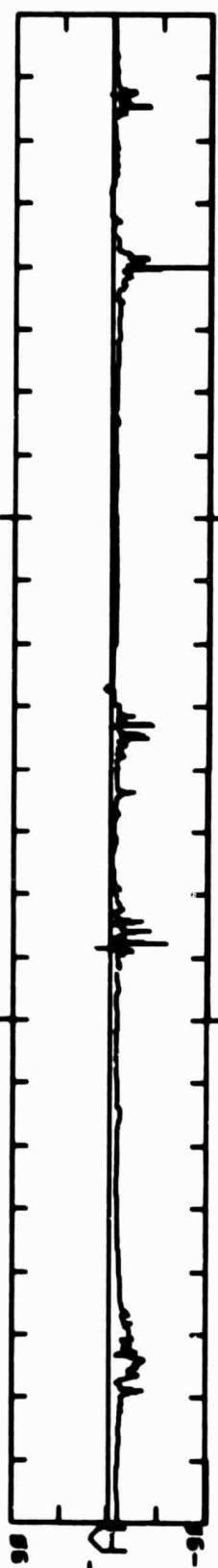
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LAMBDA



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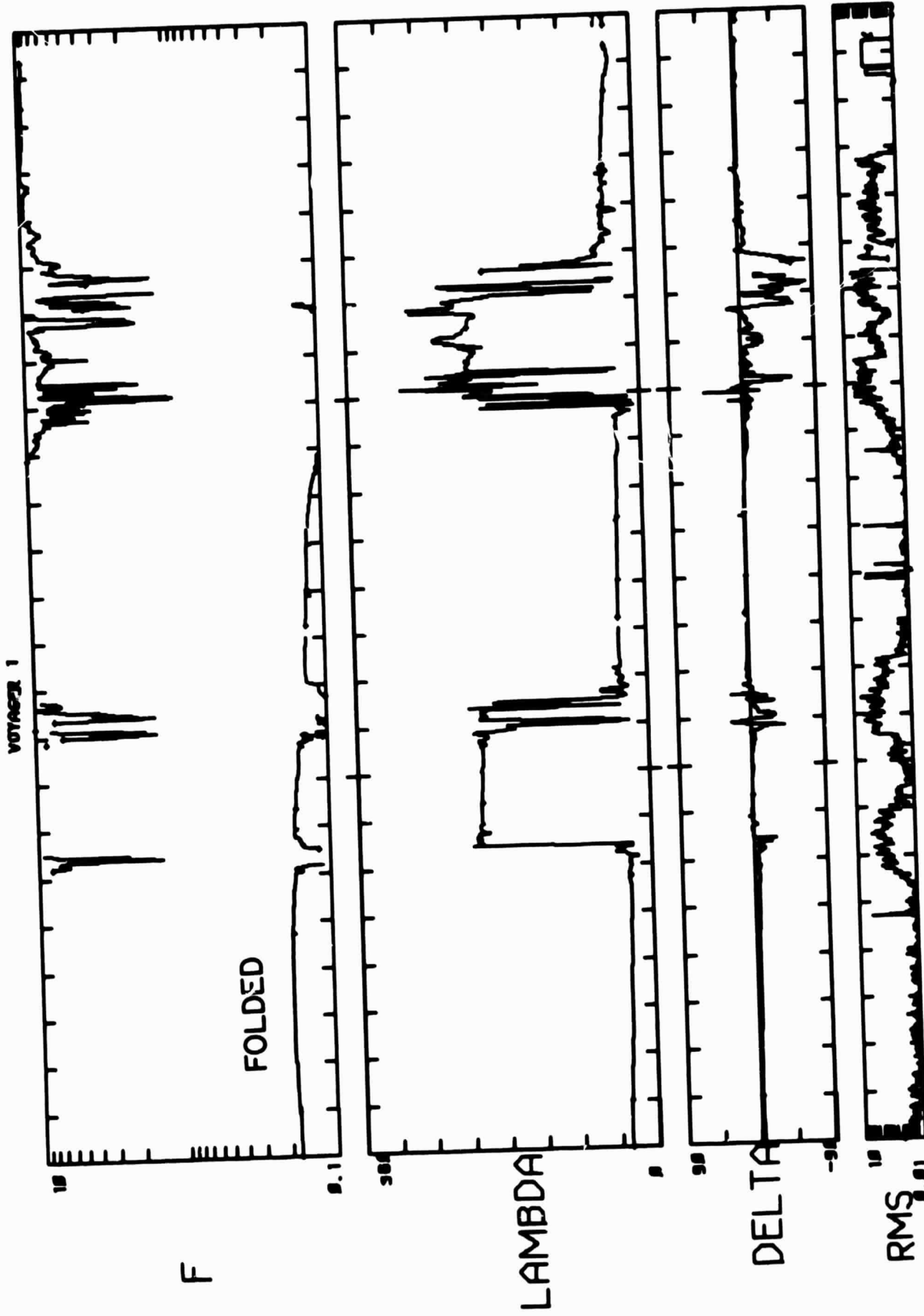


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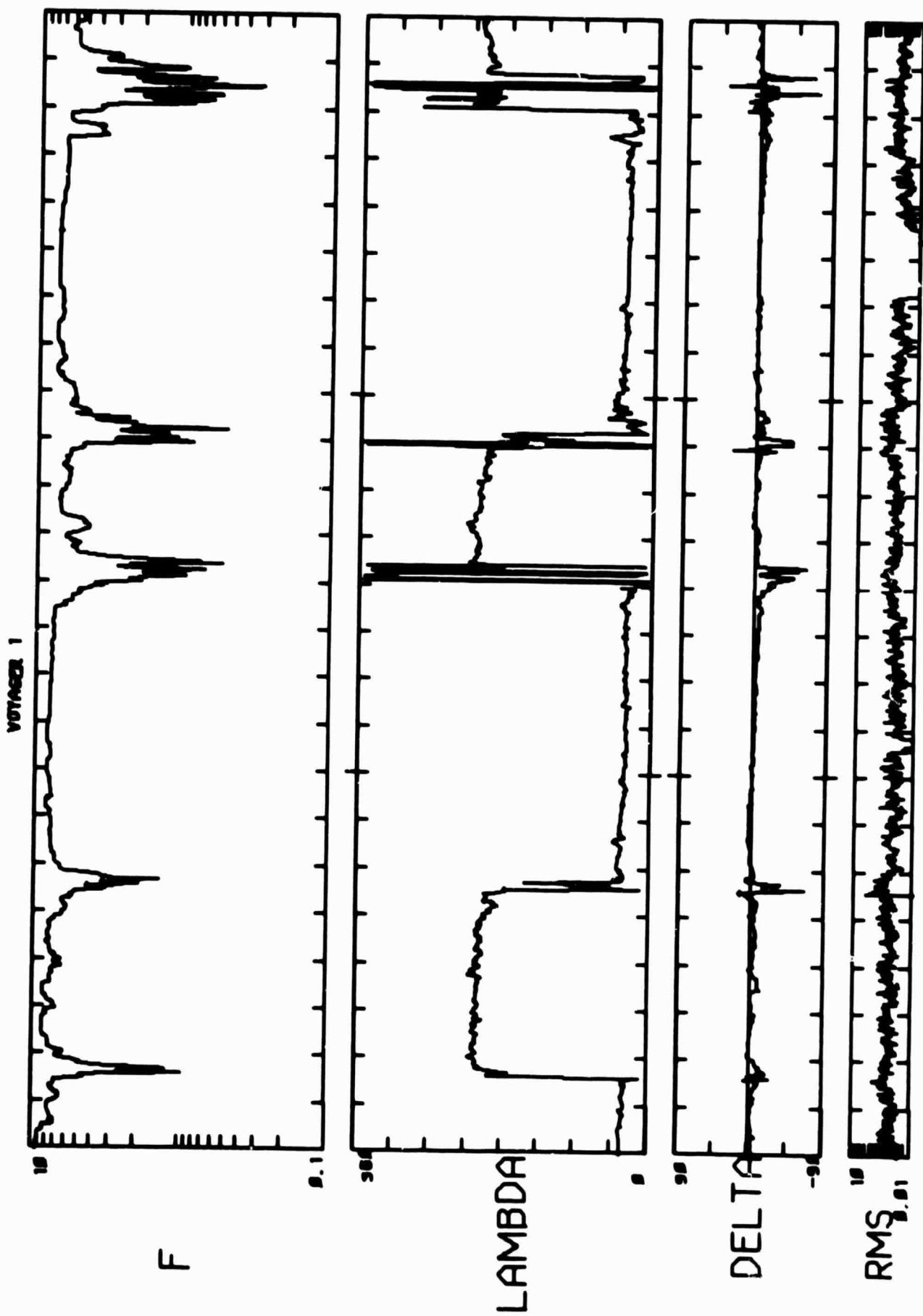
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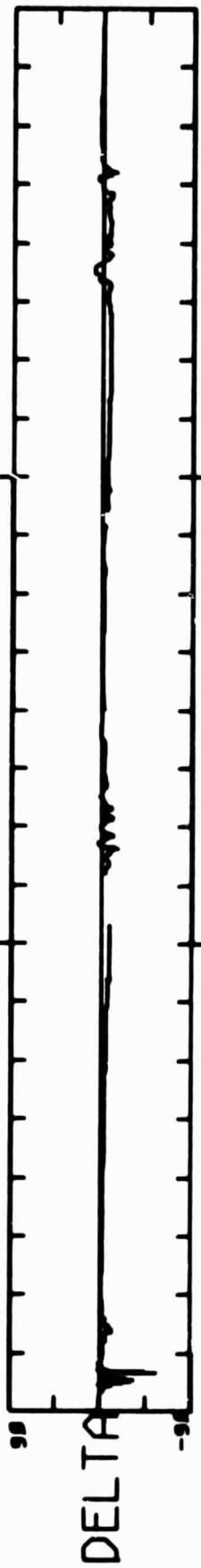
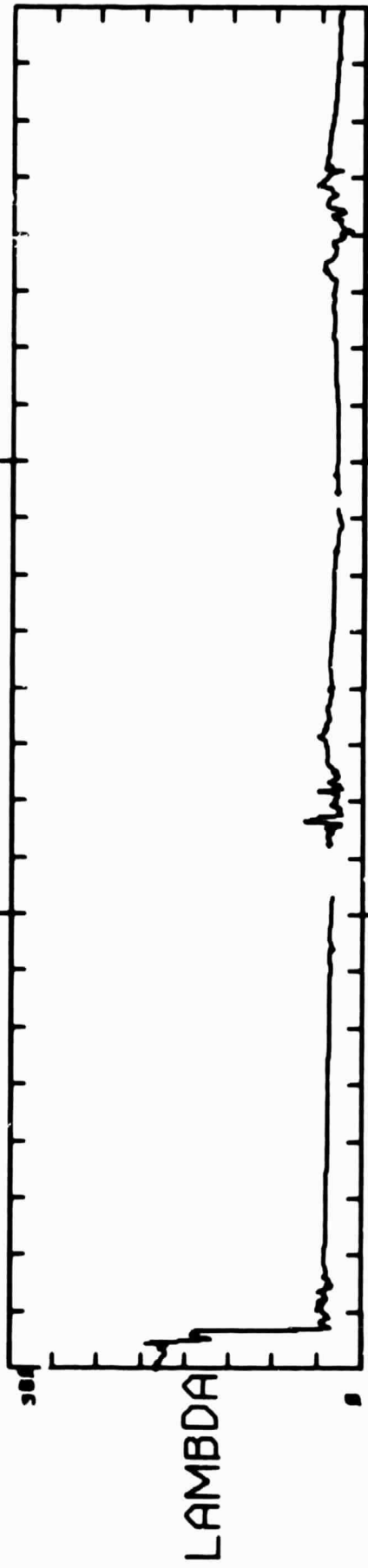
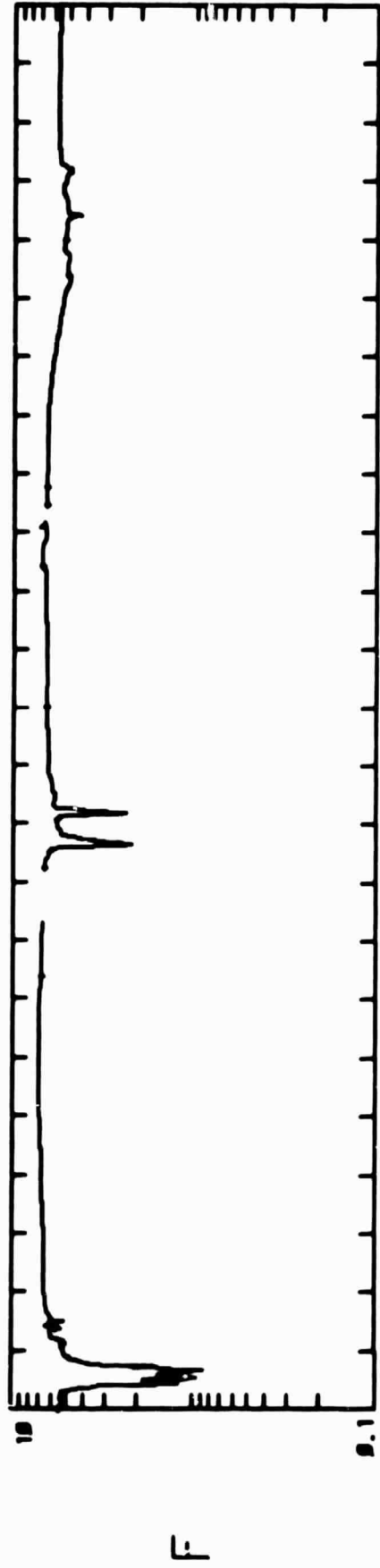


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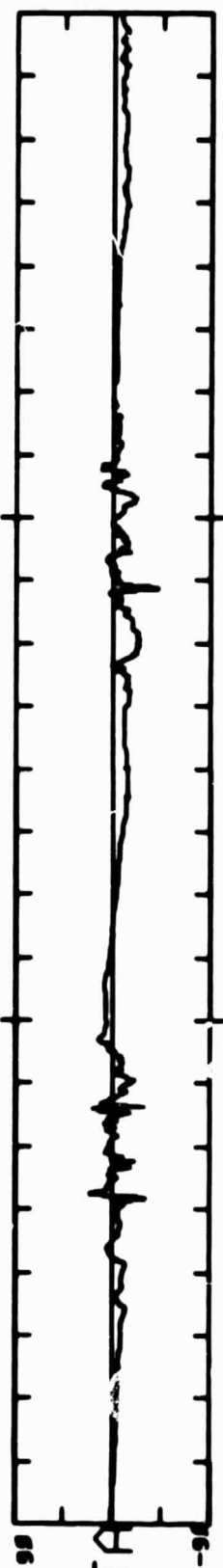
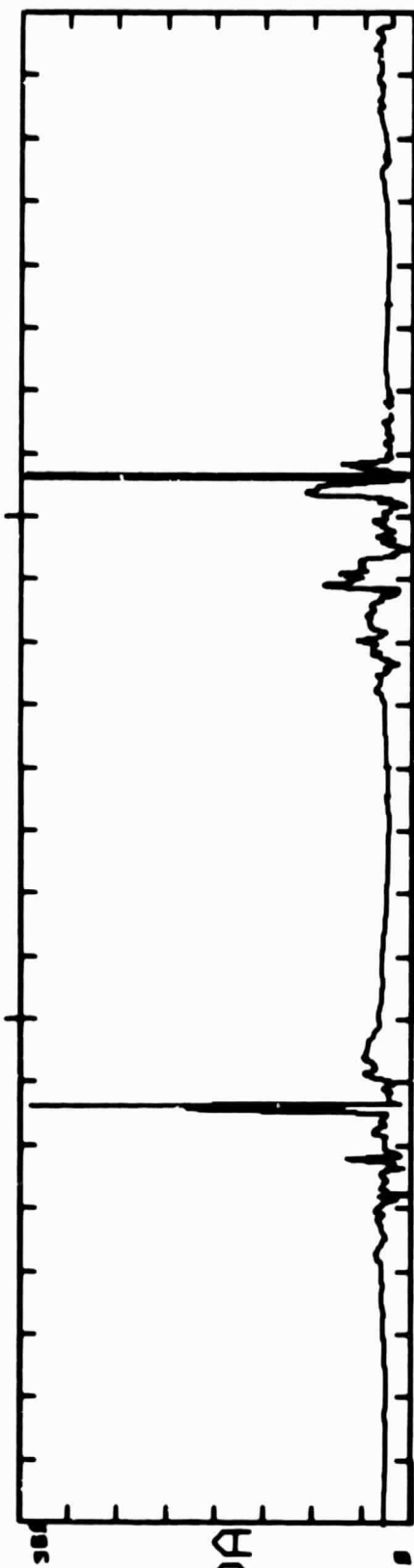
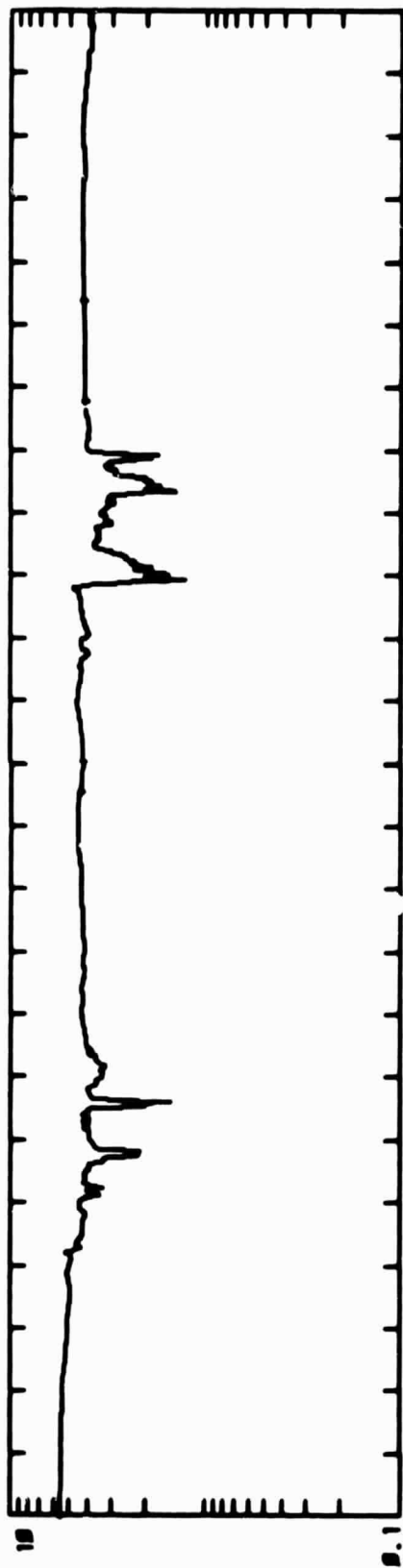
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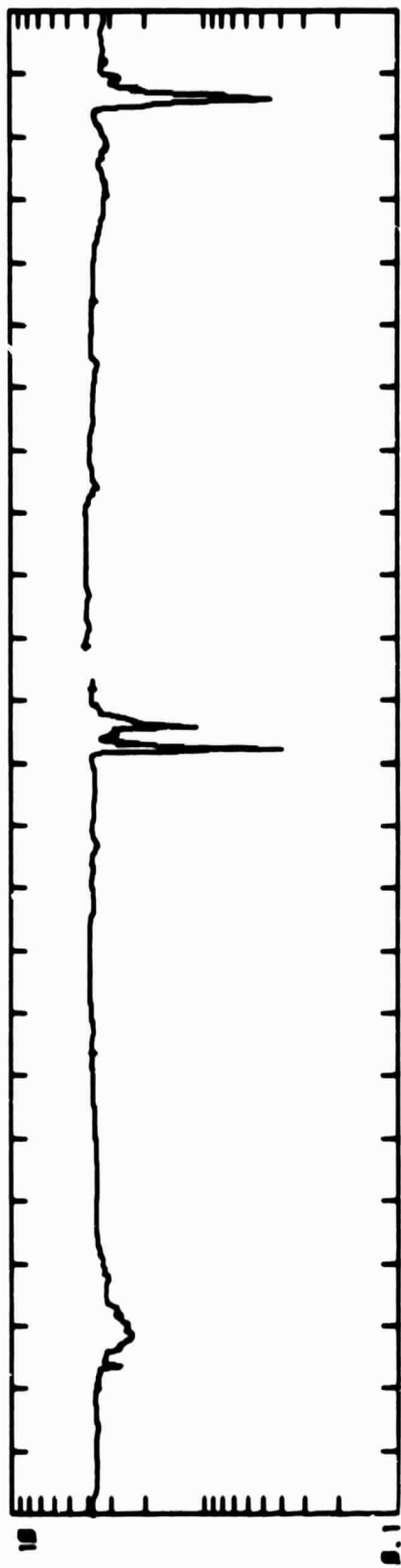
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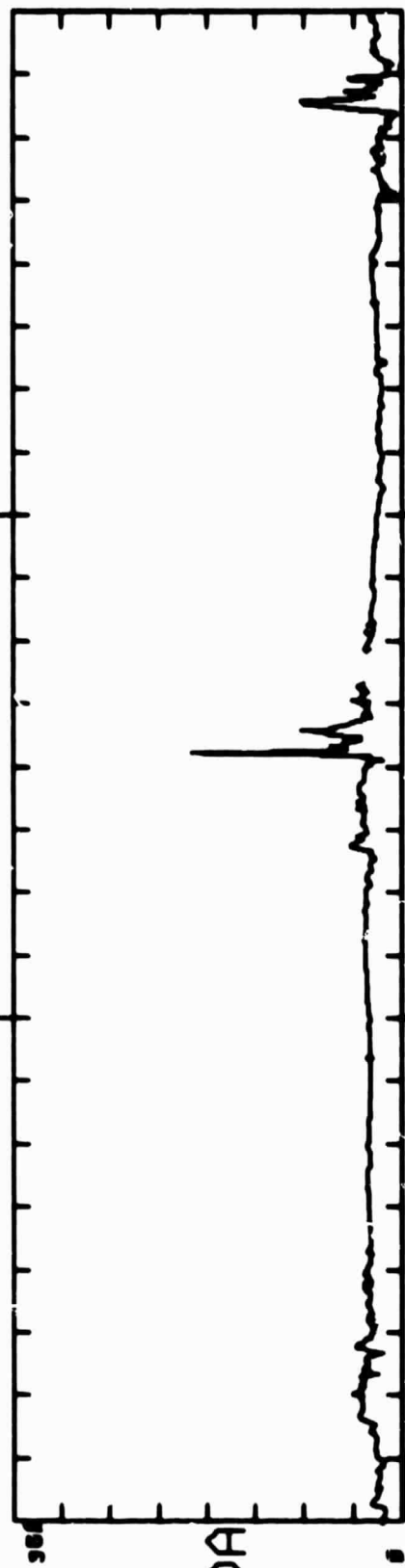
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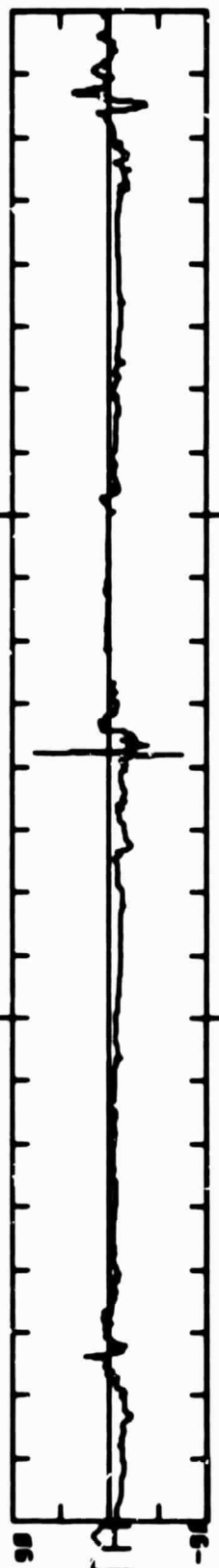
VOYAGER 1



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LAMBDA



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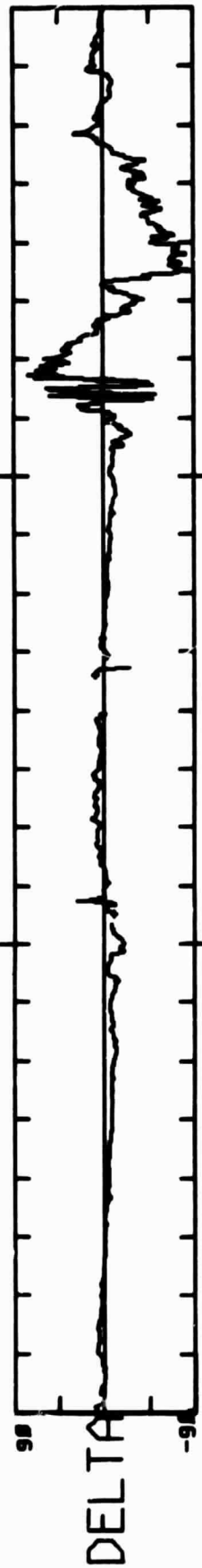
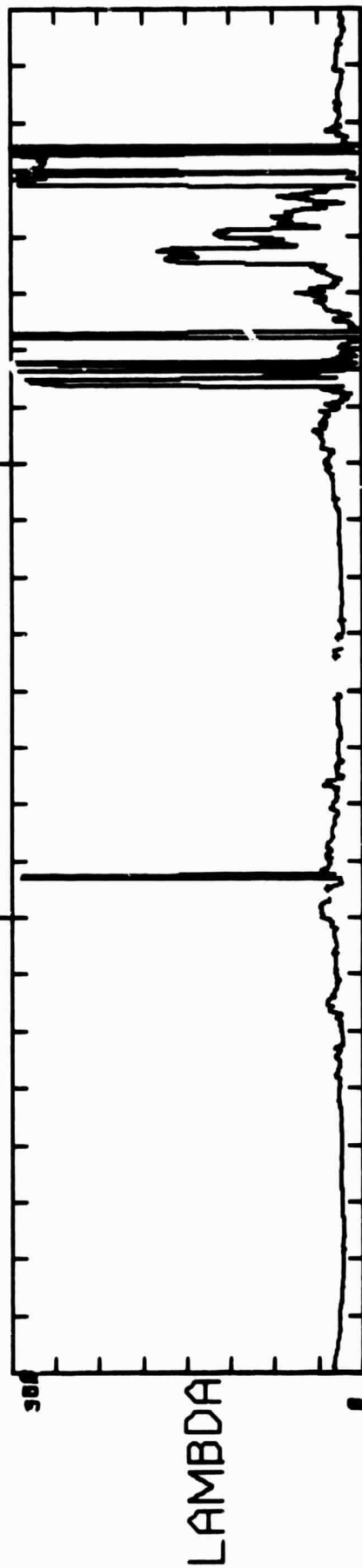
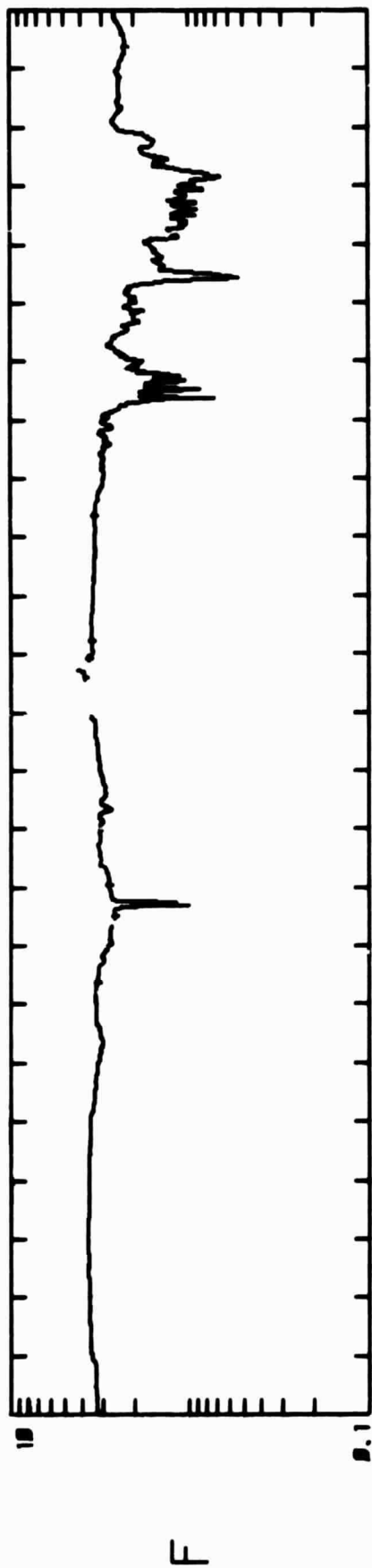


RMS

START YEAR +DAY
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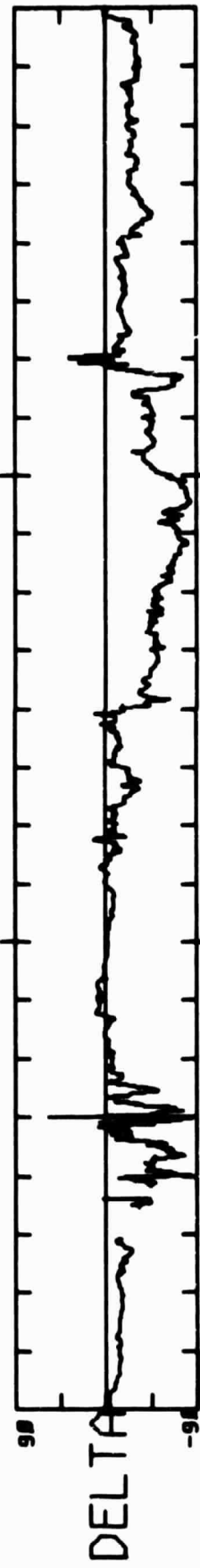
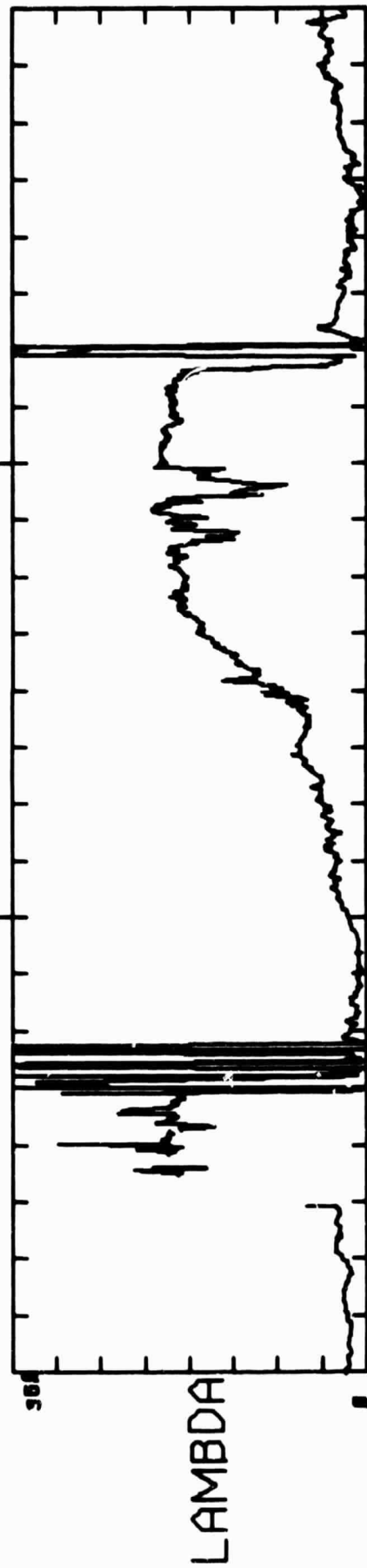
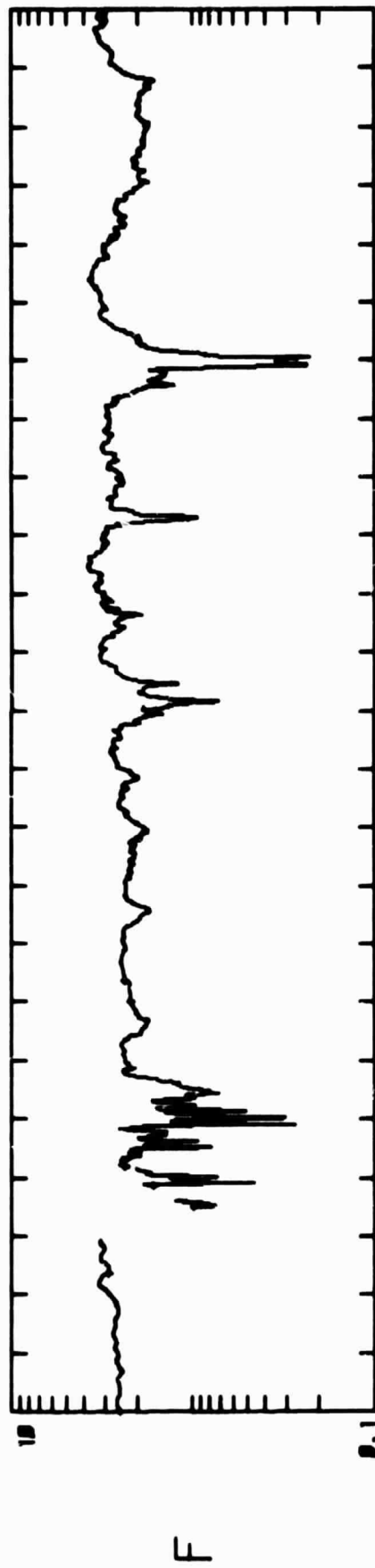
VOTAGER 1



START YEAR +DAY
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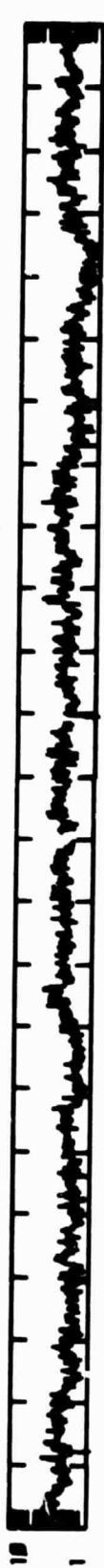
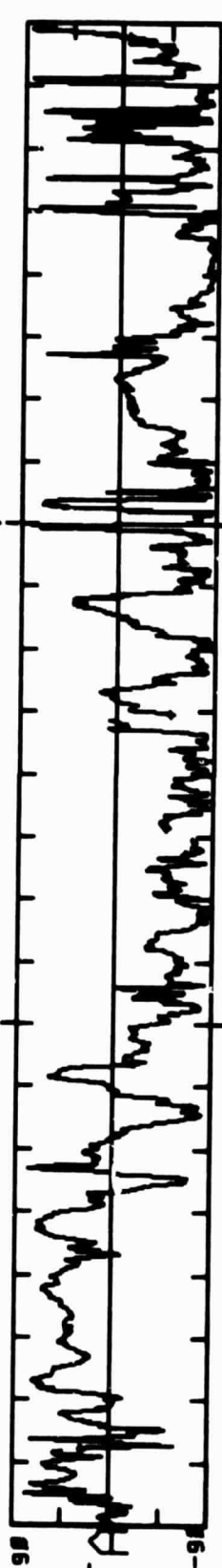
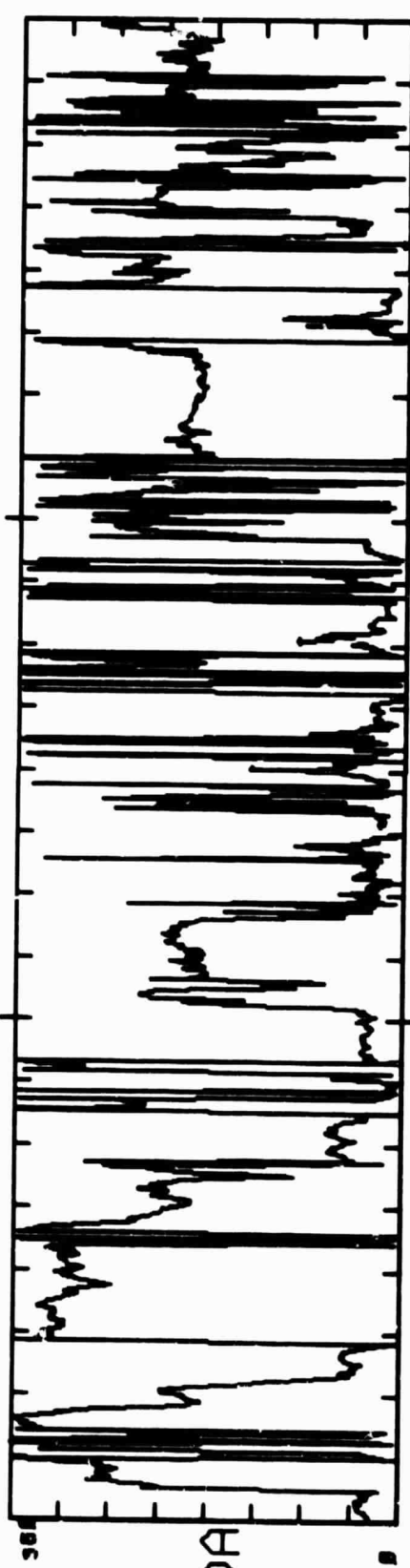
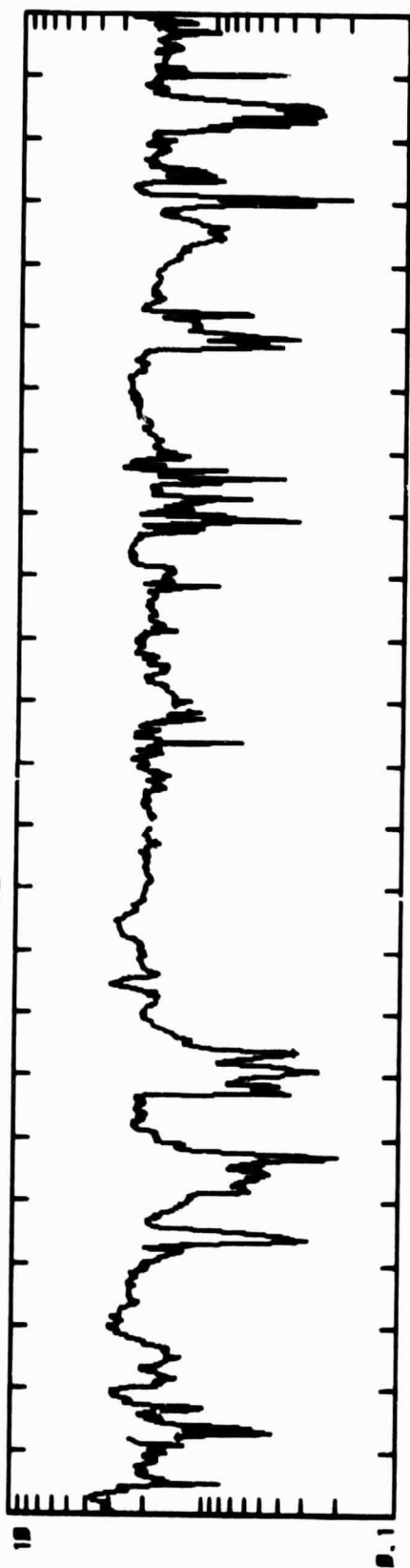
VOYAGER 1



START YEAR +DAY
79 73

14 March

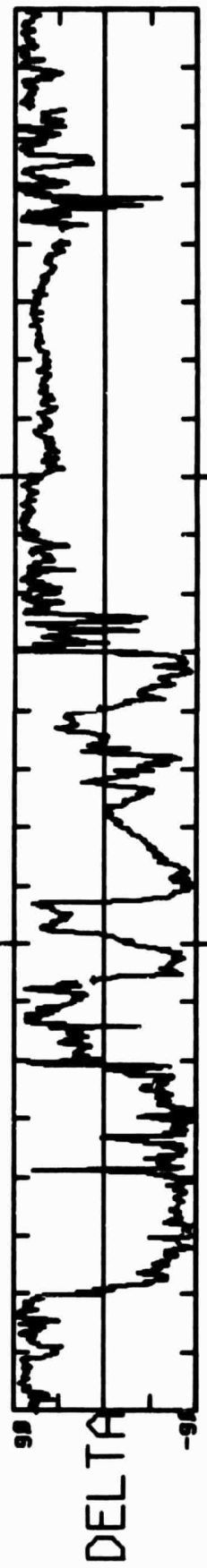
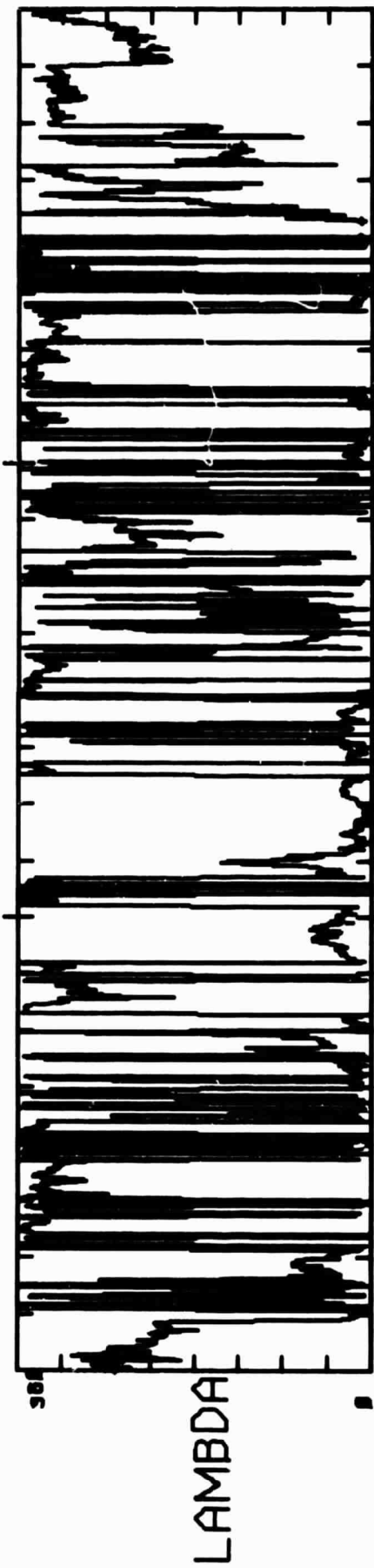
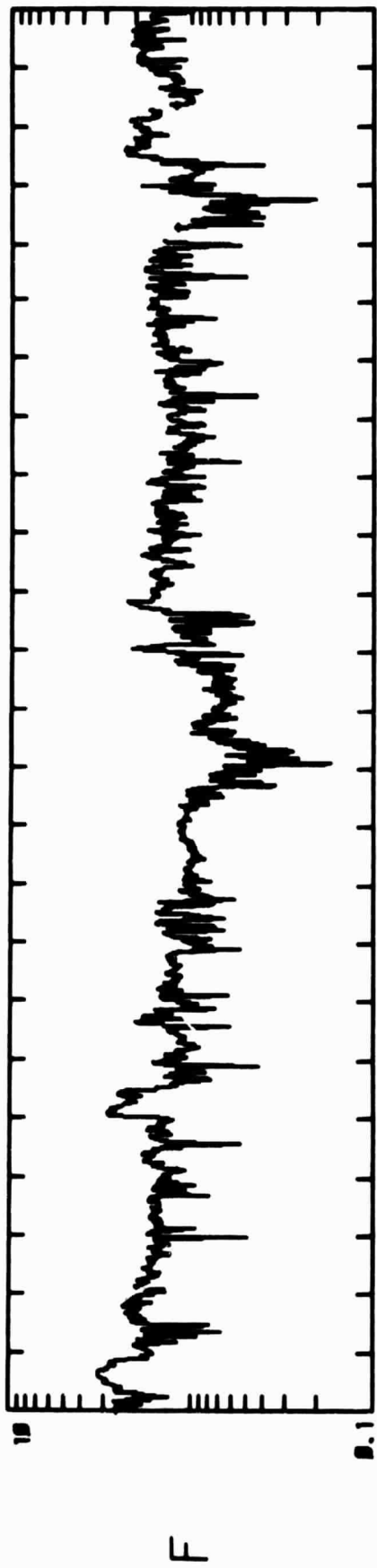
VOYAGER 1



START YEAR +DAY
79 74

15 March

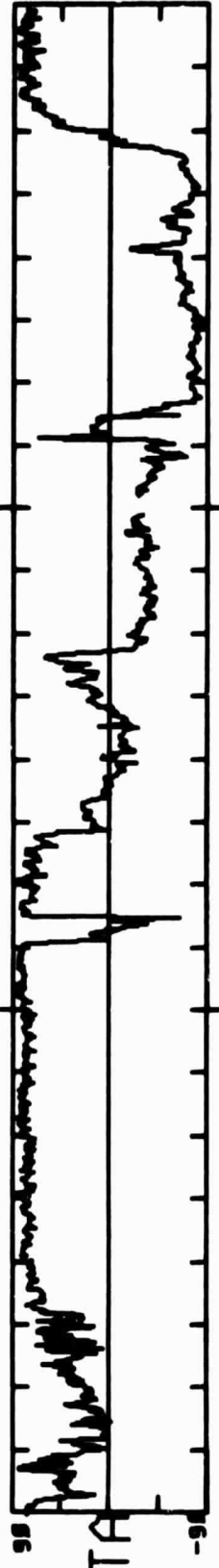
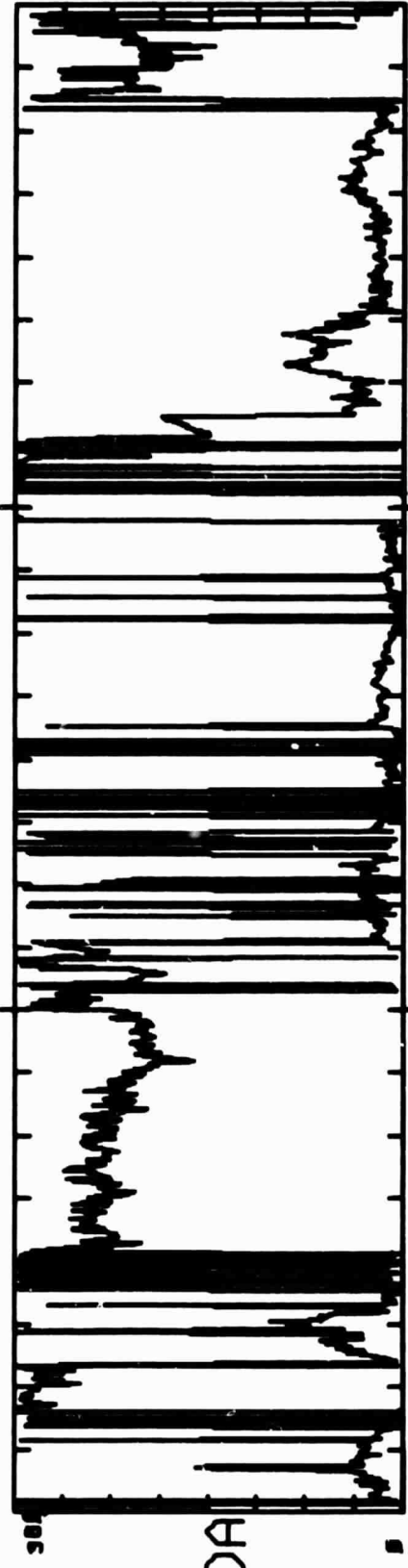
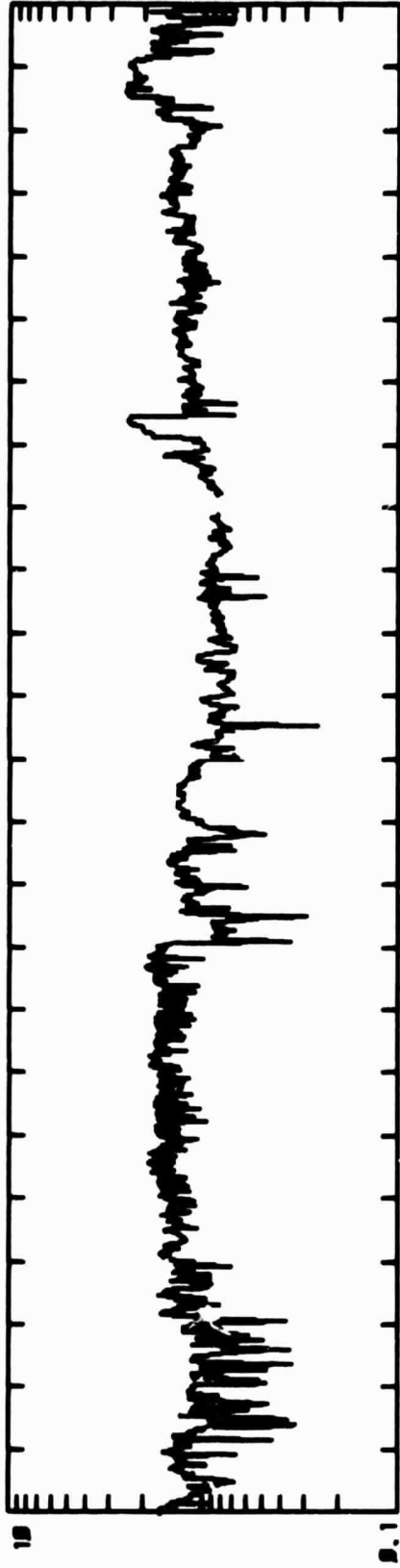
VOYAGER 1



START YEAR +DAY
79 75

16 March

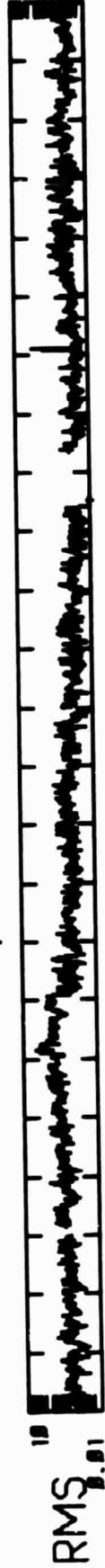
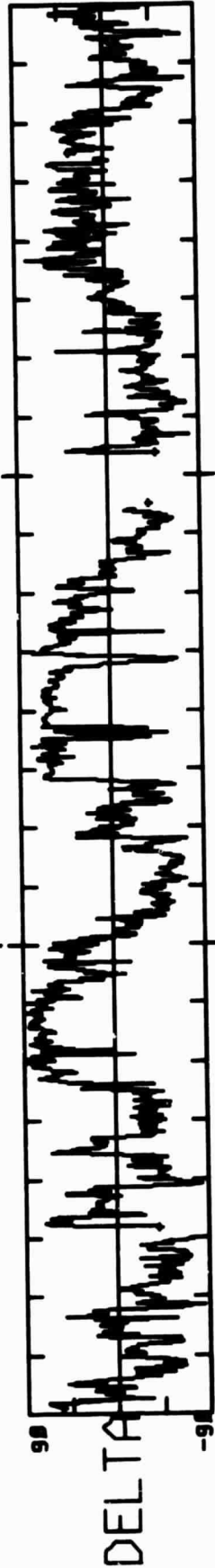
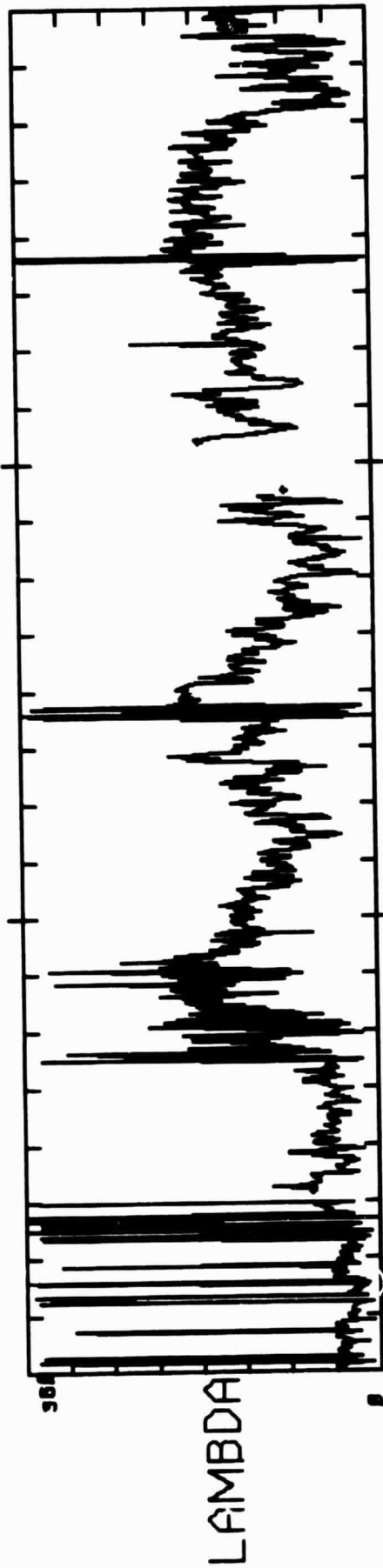
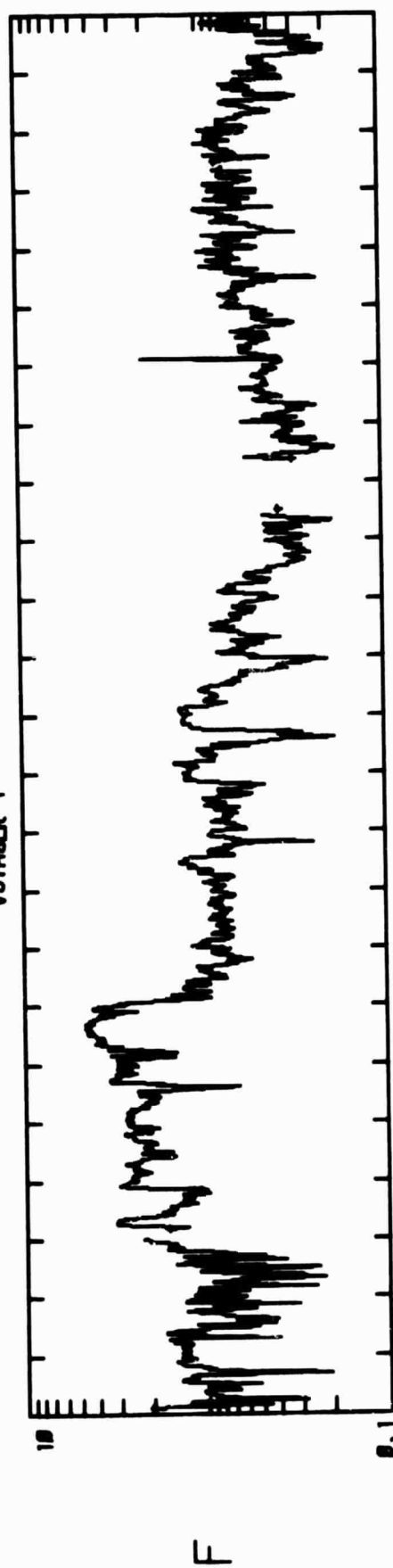
VOYAGER 1



START YEAR +DAY
79 76

17 March

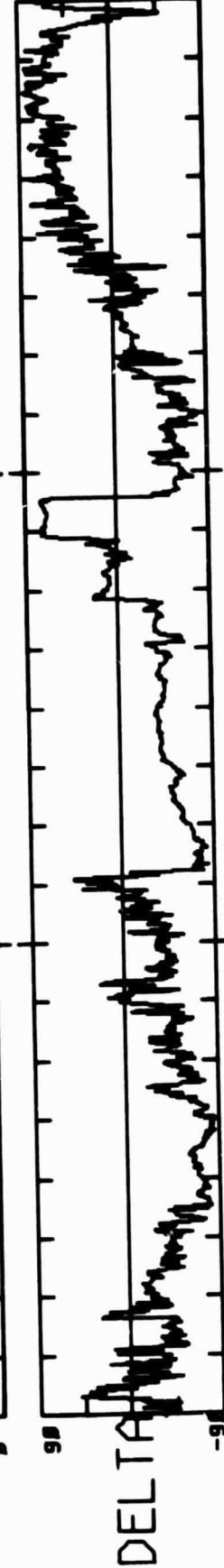
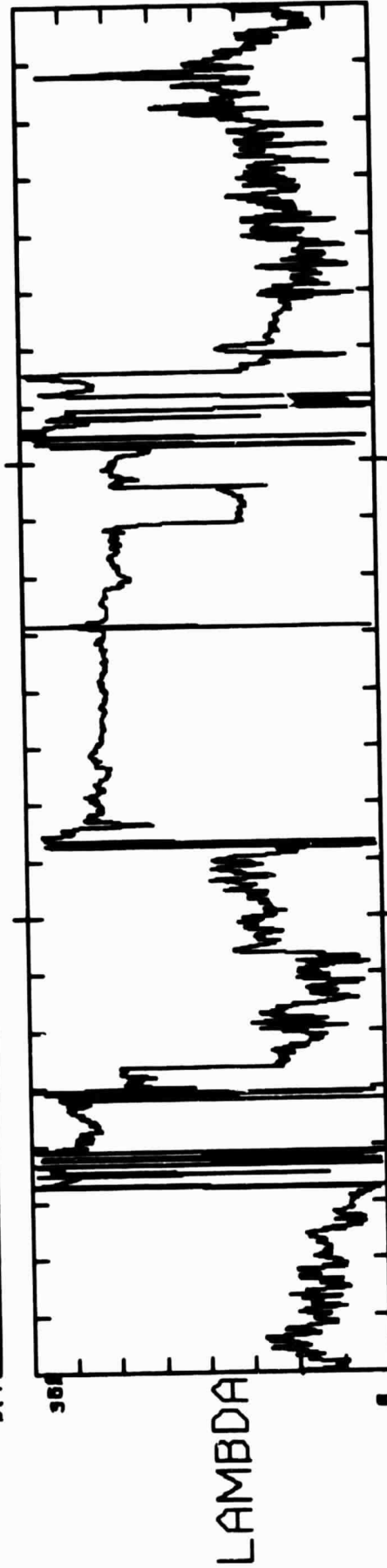
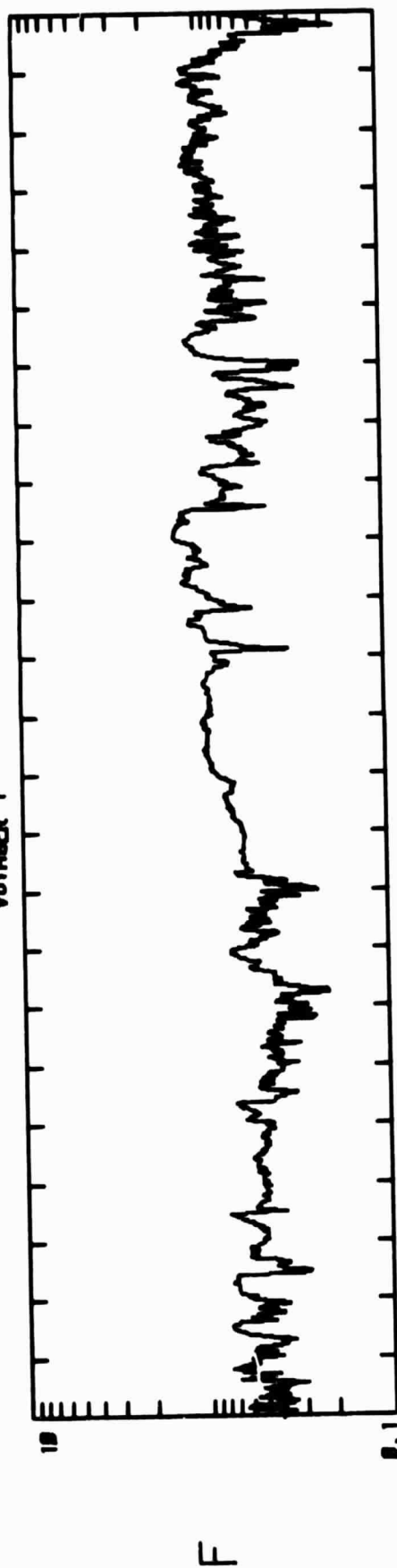
VOYAGER 1



START YEAR +DAY
79 77

18 March

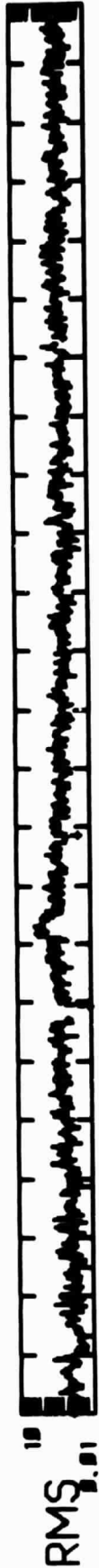
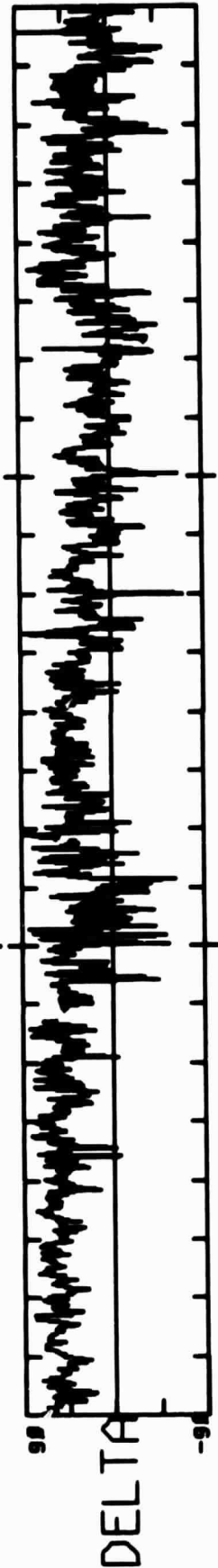
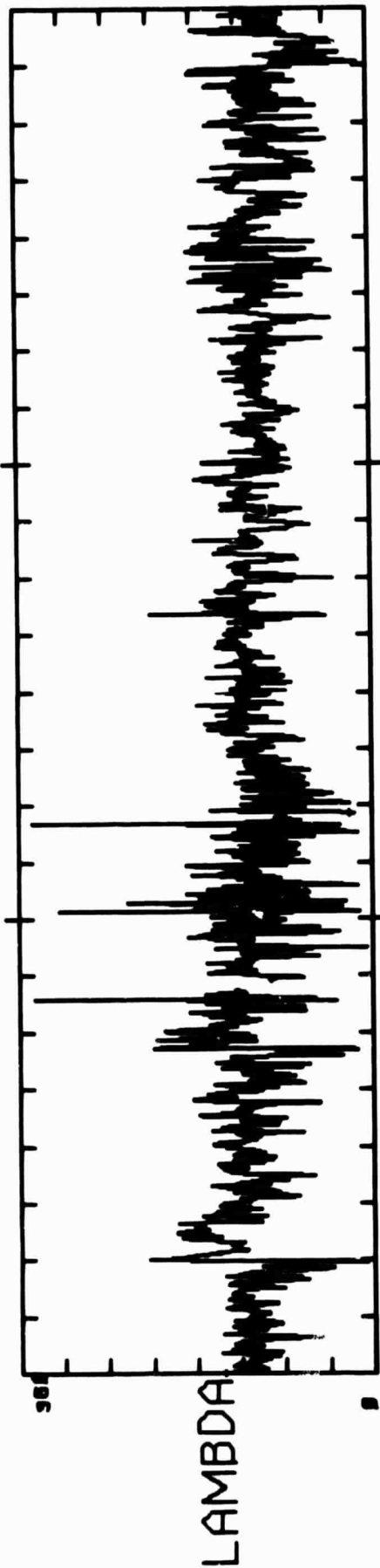
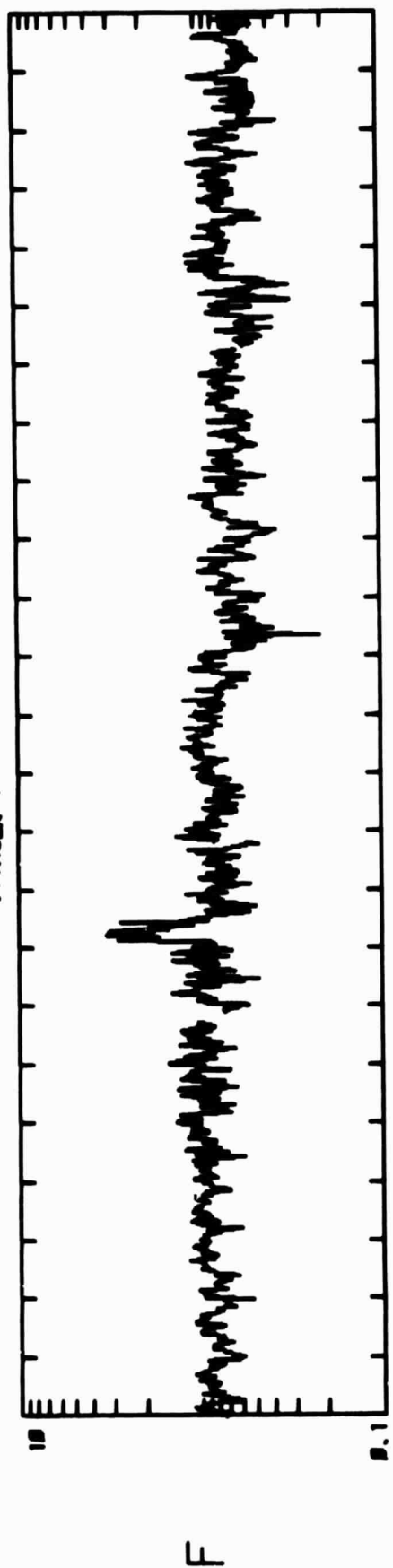
VOYAGER 1



START YEAR +DAY
79 78

19 March

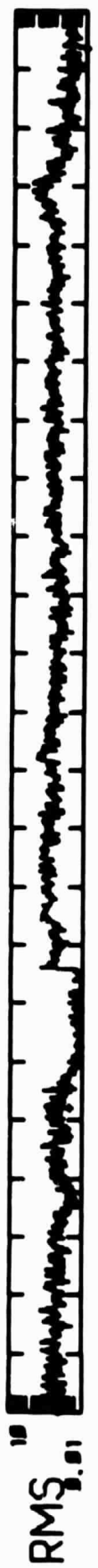
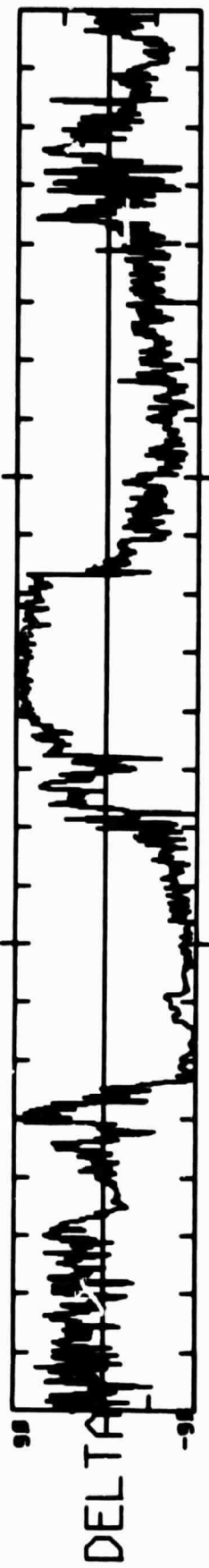
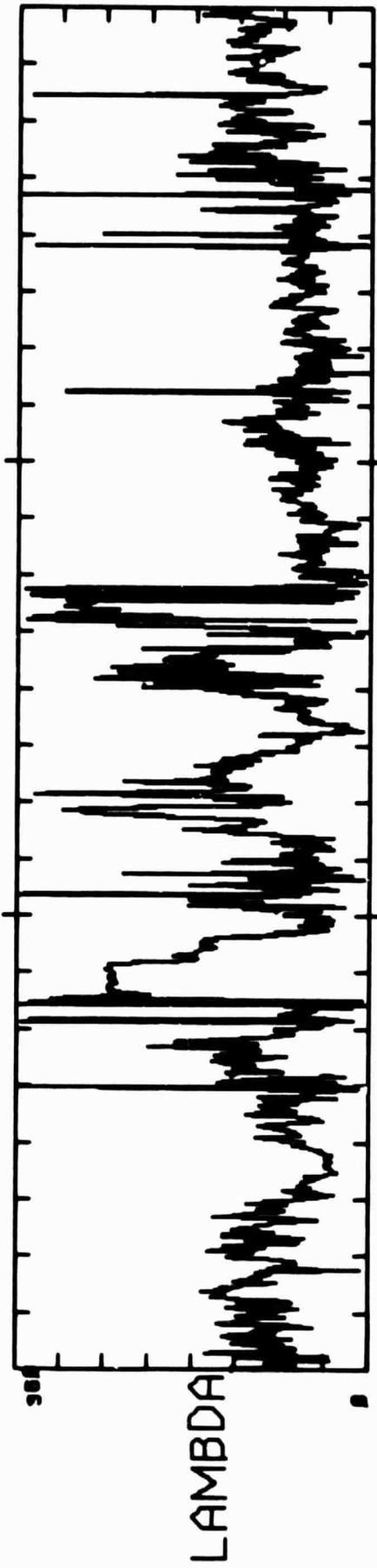
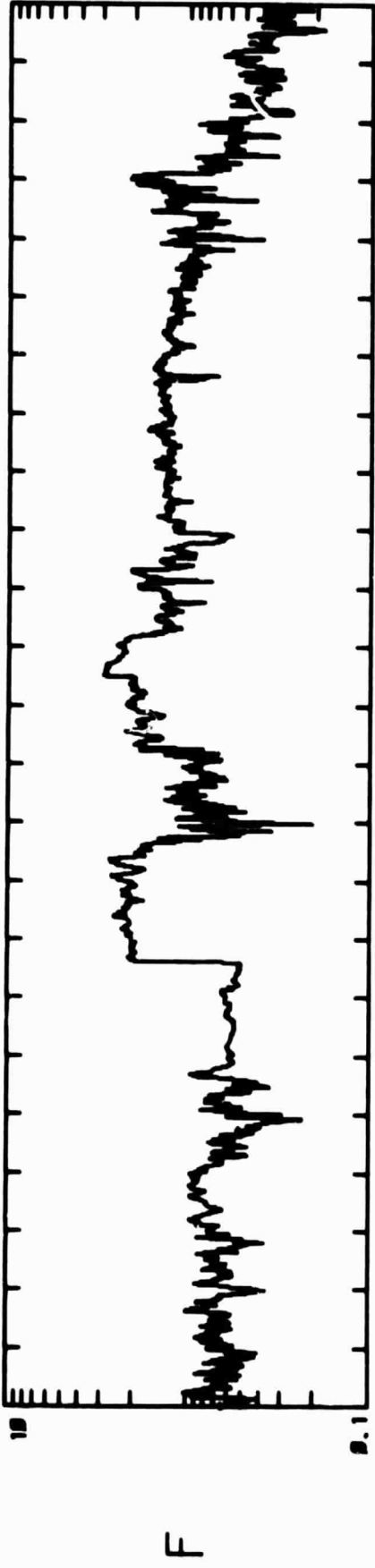
VOYAGER 1



START YEAR +DAY
79 79

20 March

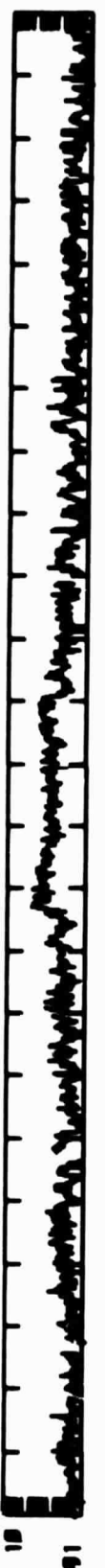
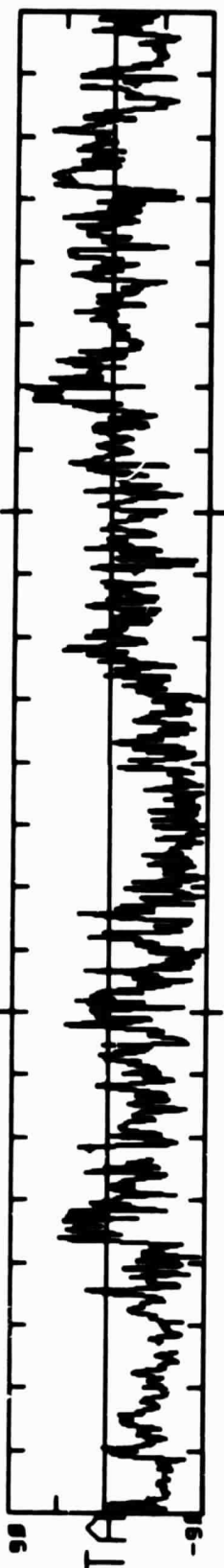
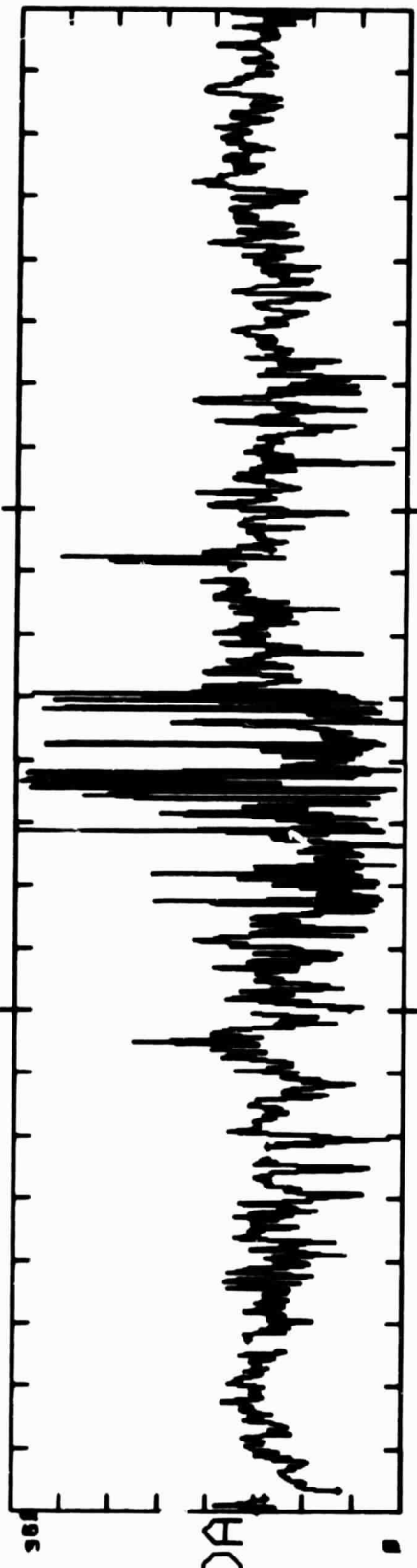
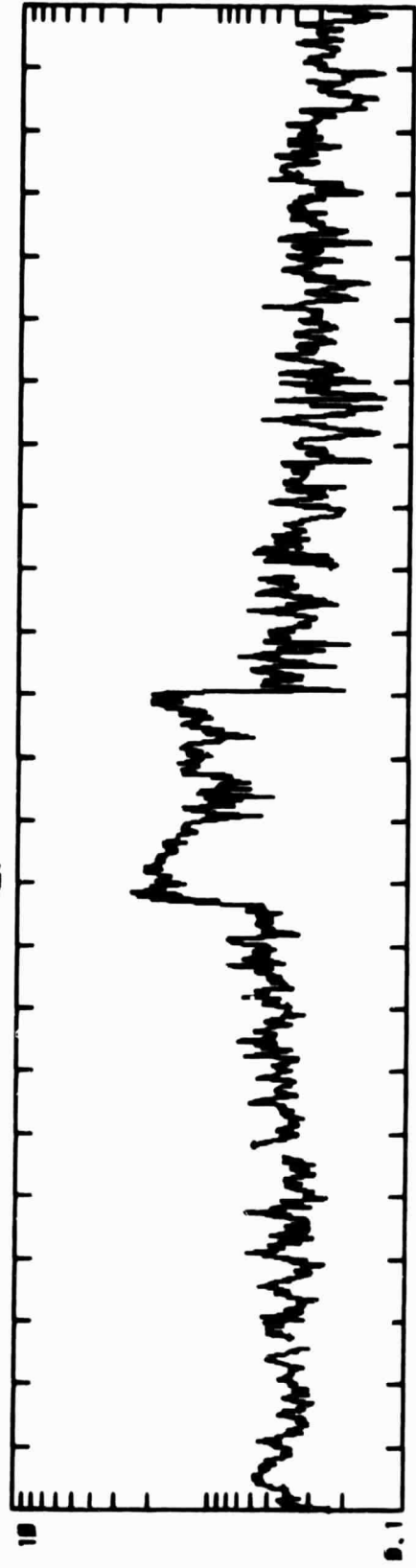
VOYAGER 1



START YEAR +DAY
79 80

21 March

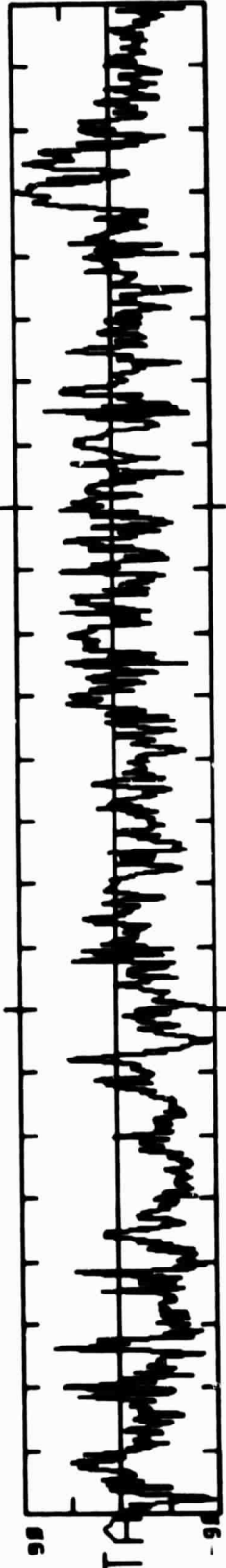
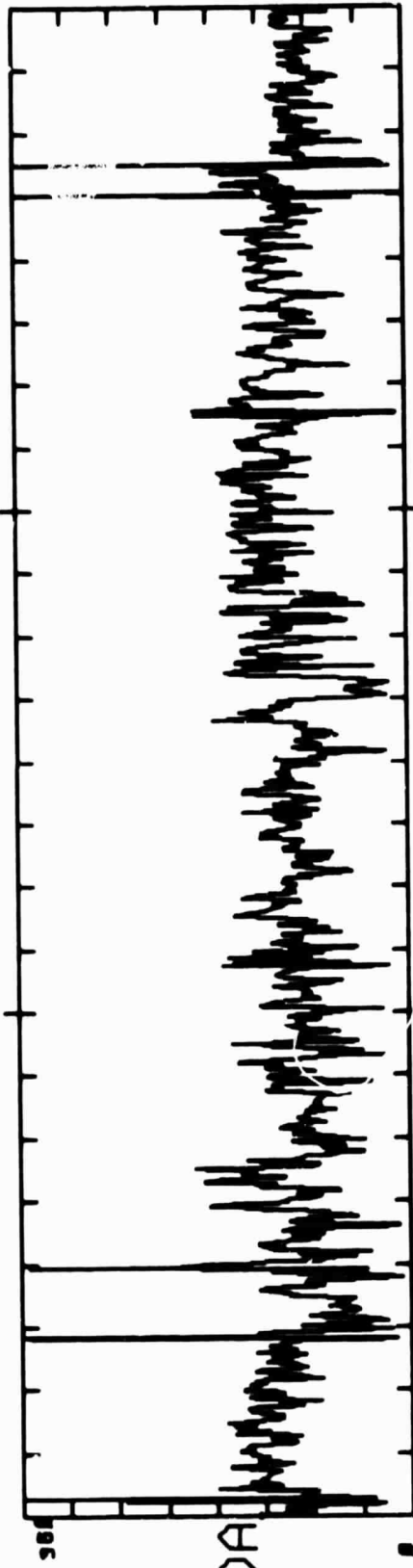
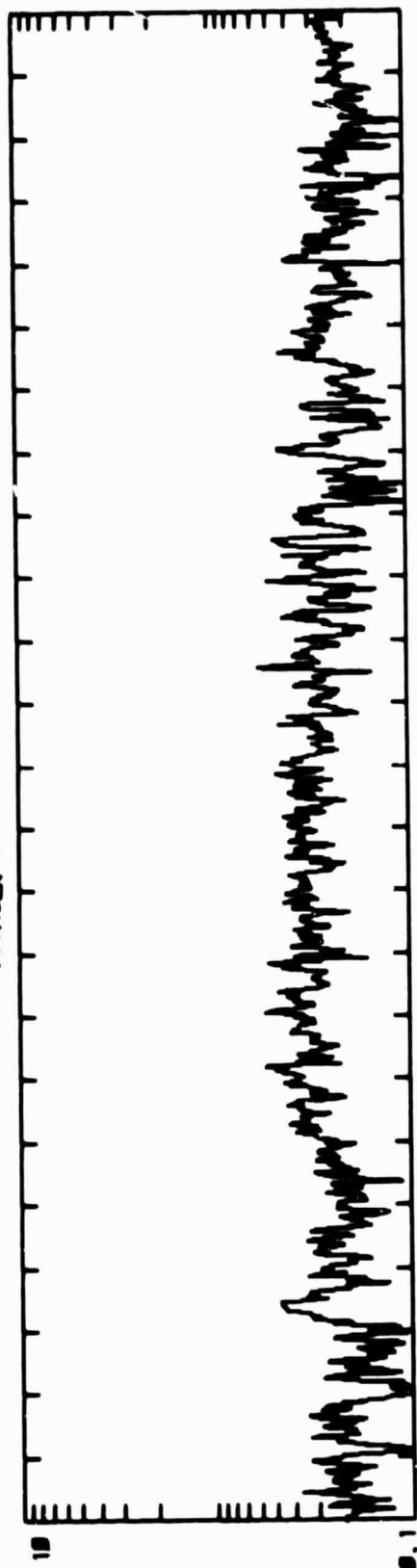
VOYAGER 1



START YEAR +DAY
79 81

22 March

VOYAGER 1



START YEAR +DAY
79 82

23 March

VOYAGER 2

DAILY PLOTS OF 48-SEC MAGNETIC FIELD DATA

(2 July 1979 to 14 August, inclusive)

F, magnitude in nT

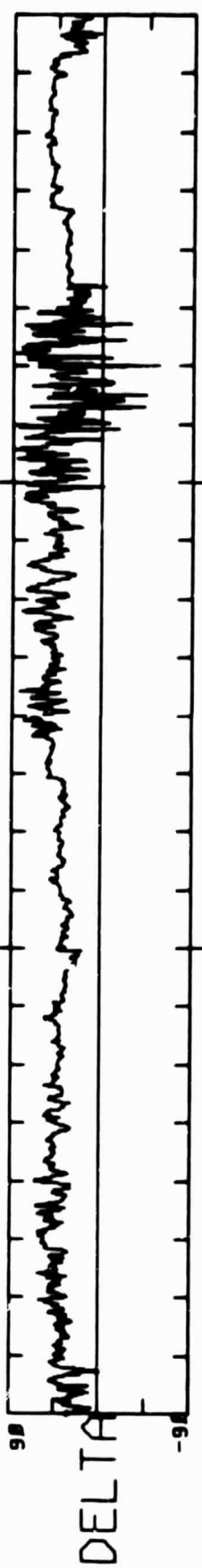
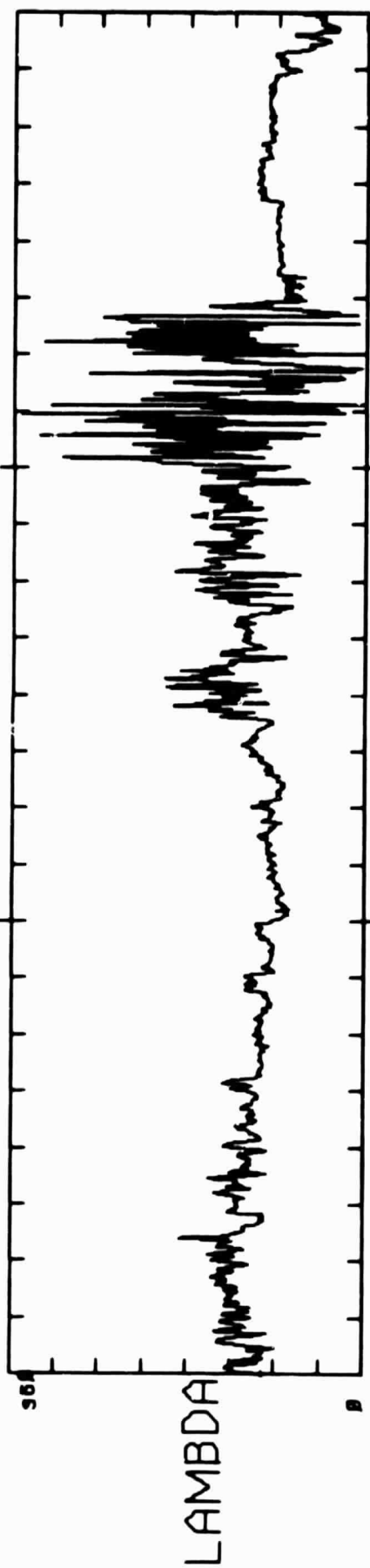
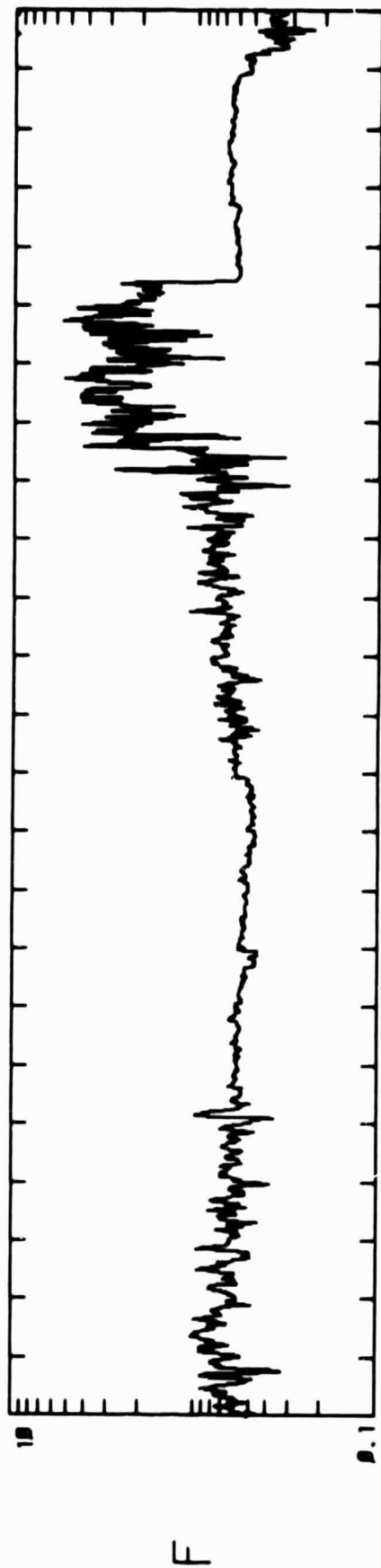
LAMDA, longitude

DELTA, latitude

RMS, pythagorean root-mean-square-deviation in nT

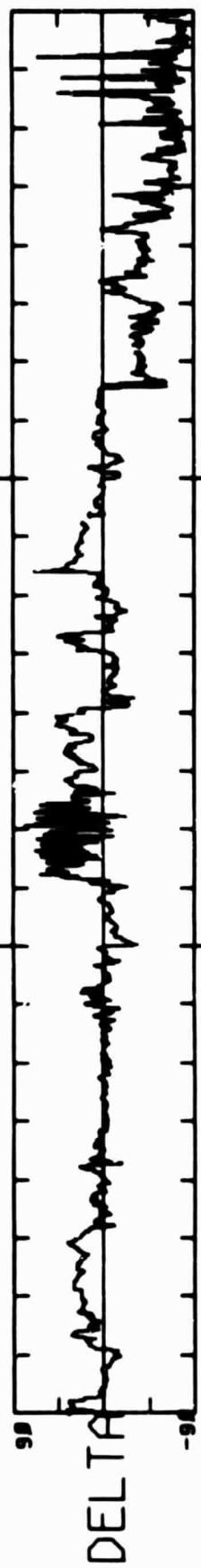
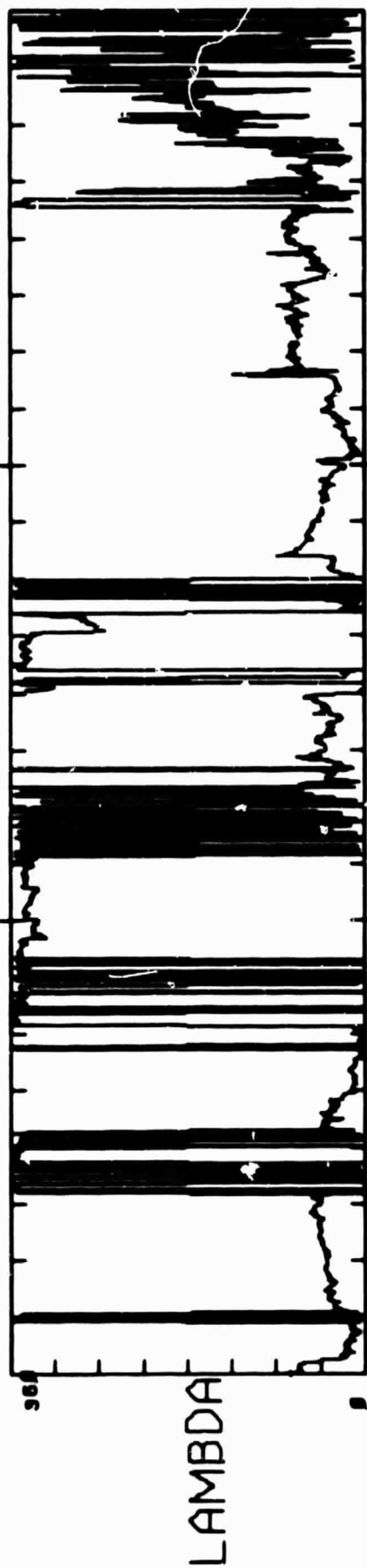
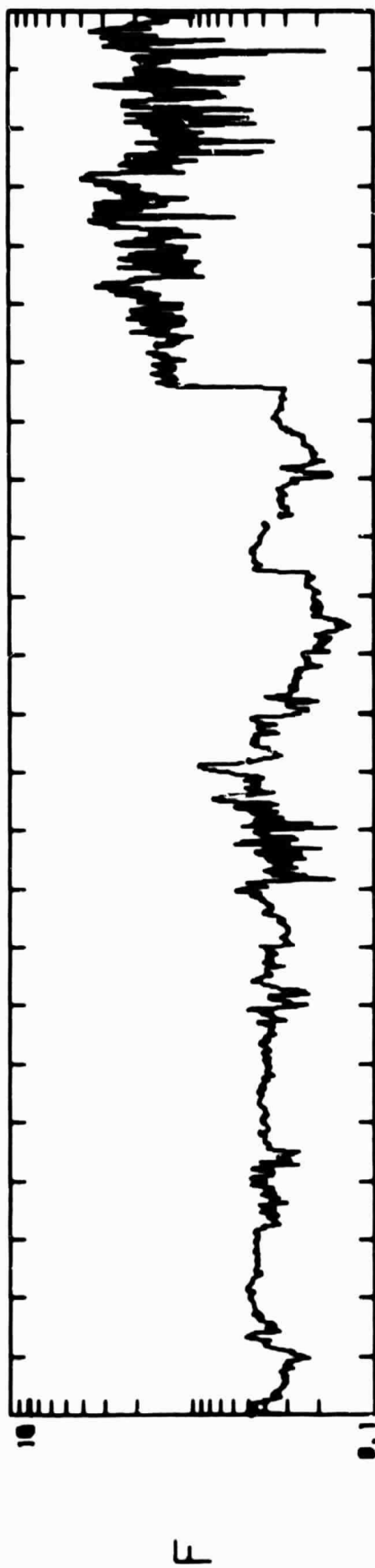
in heliographic coordinates; see text for definitions. Time is in spacecraft universal time and days are in calendar-day-of-year (DCY) such that Jan 1 = Day 1.

Voyager 2



START YEAR + DAY

2 July



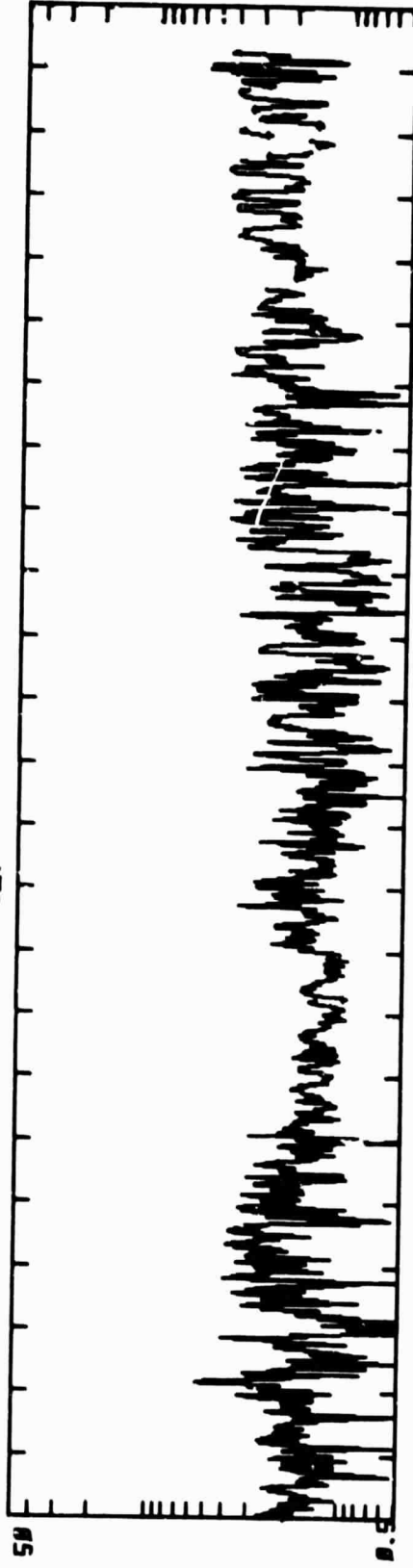
START YEAR + DAY
79 184

3 July

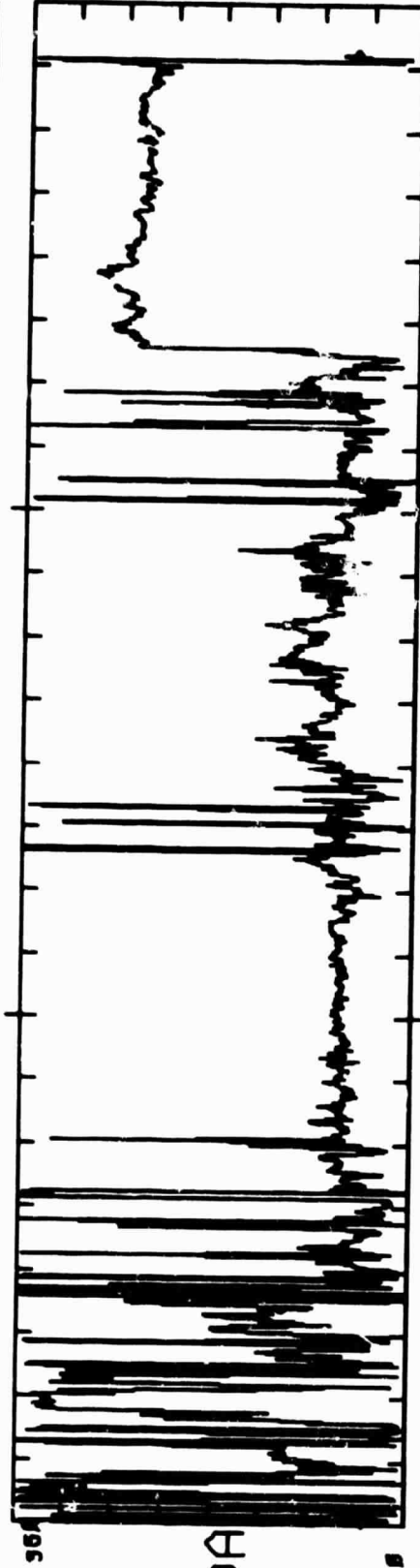
NOTE SCALE CHANGE

VOYAGER 2

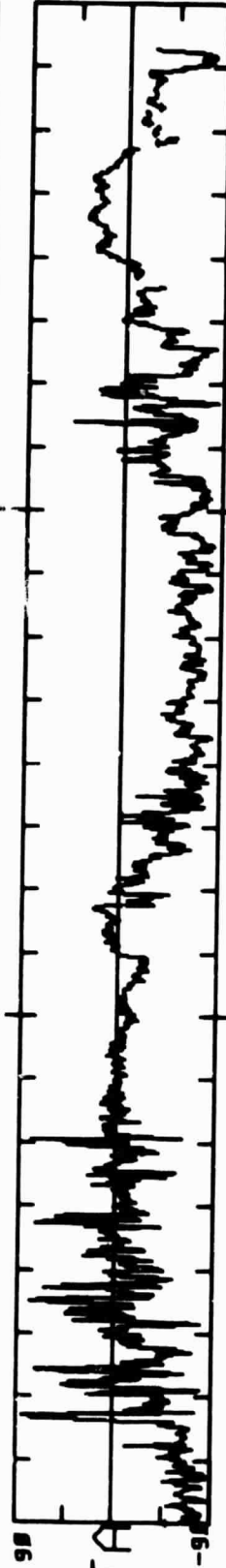
F



LAMBDA



DELTA

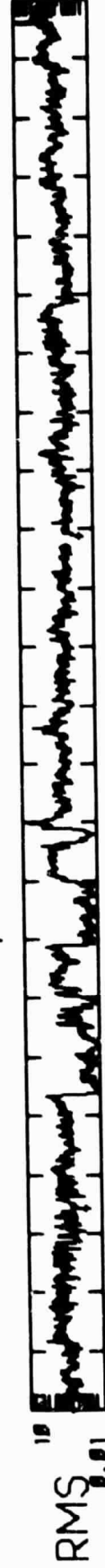
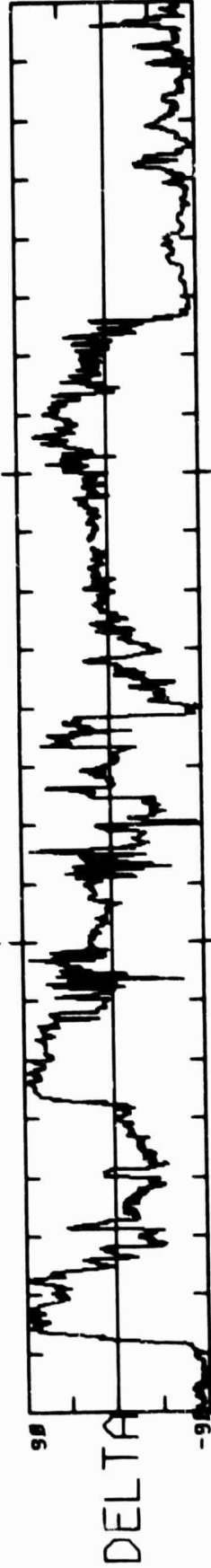
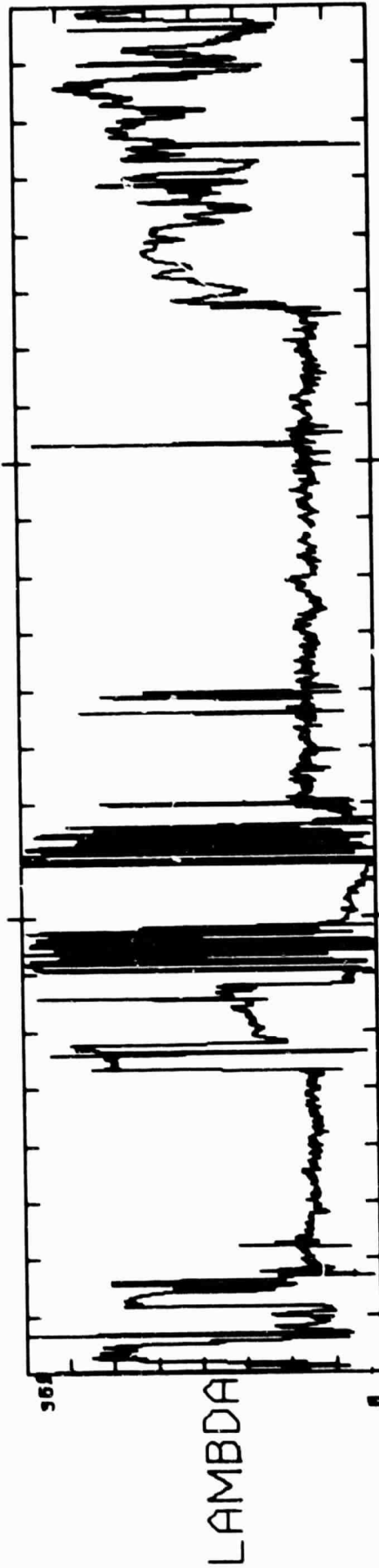
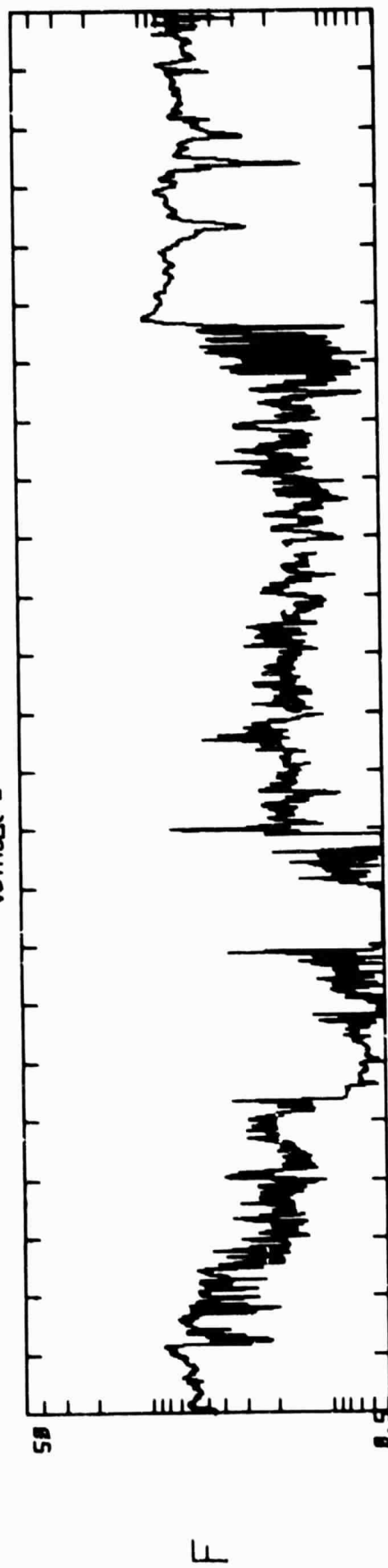


RMS



START YEAR +DAY
79 185

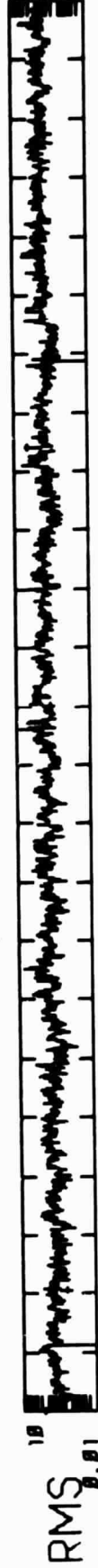
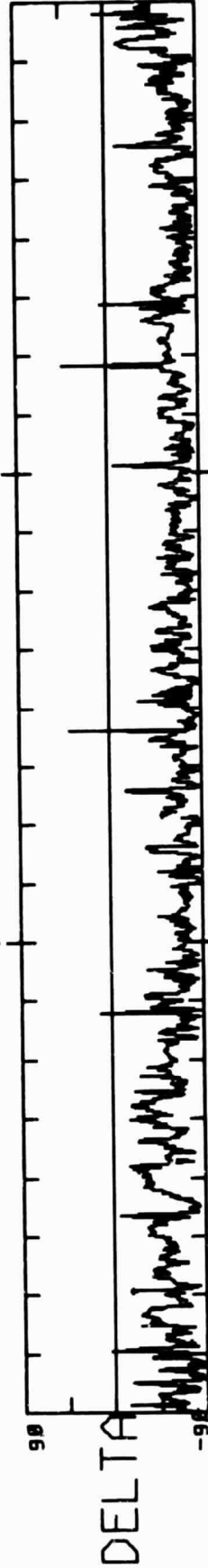
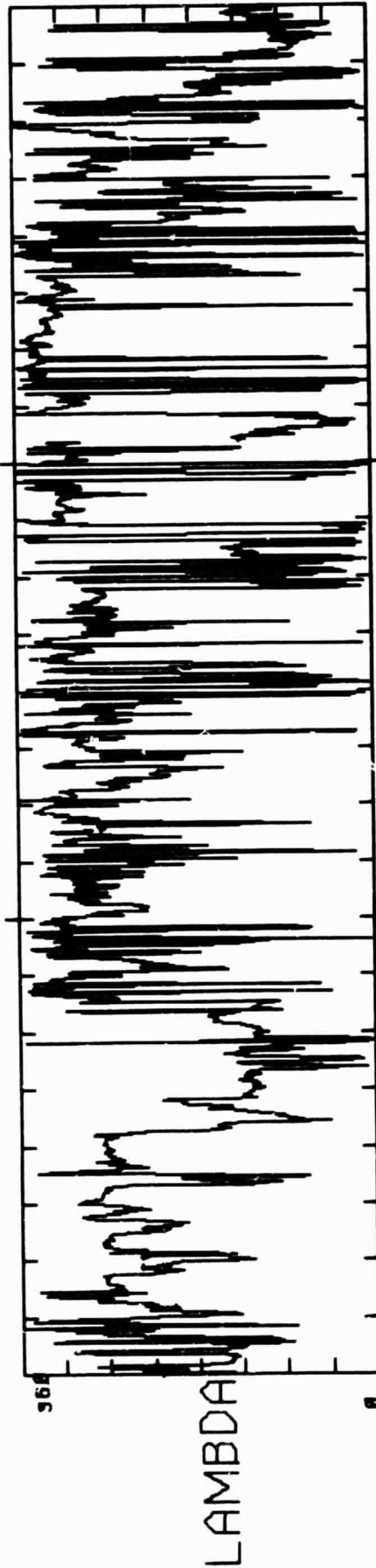
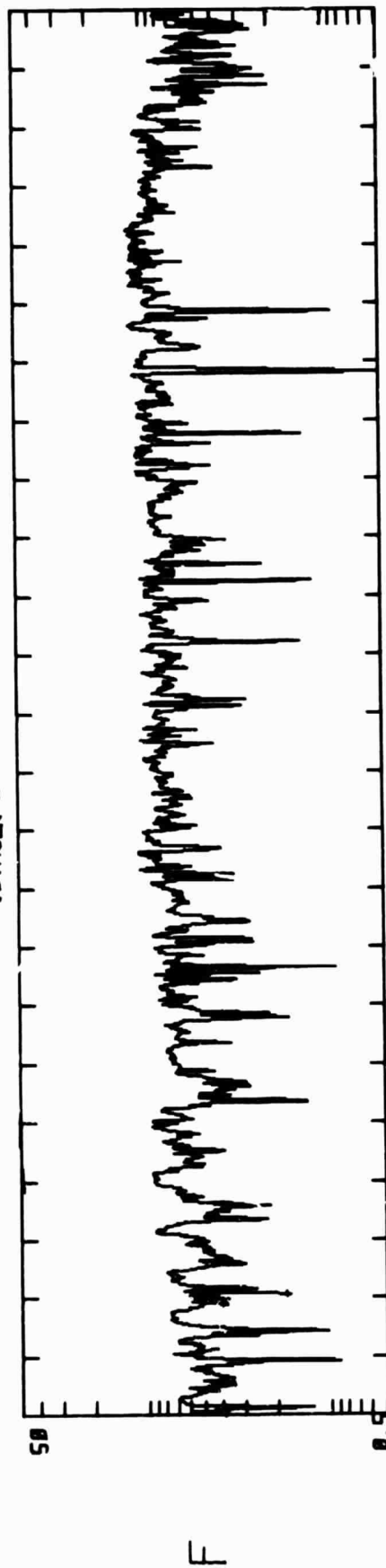
4 July



START YEAR +DAY 79 186

5 July

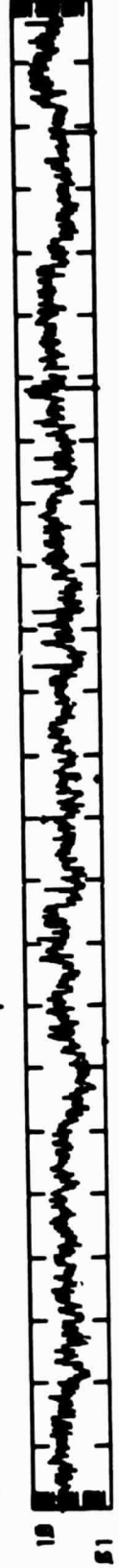
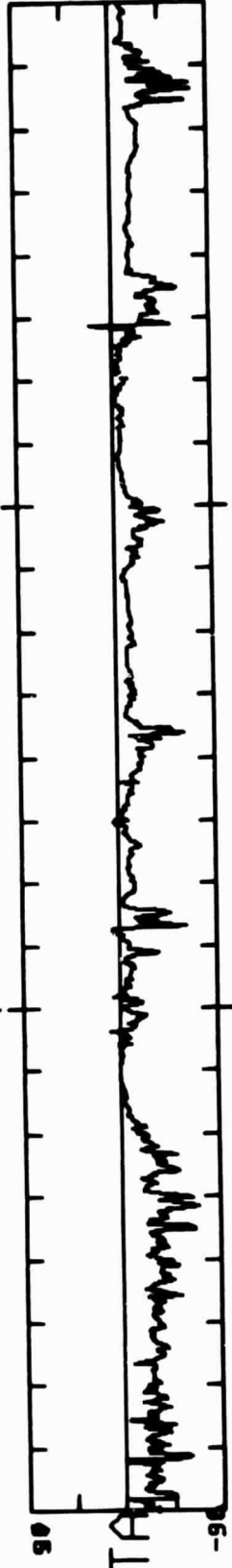
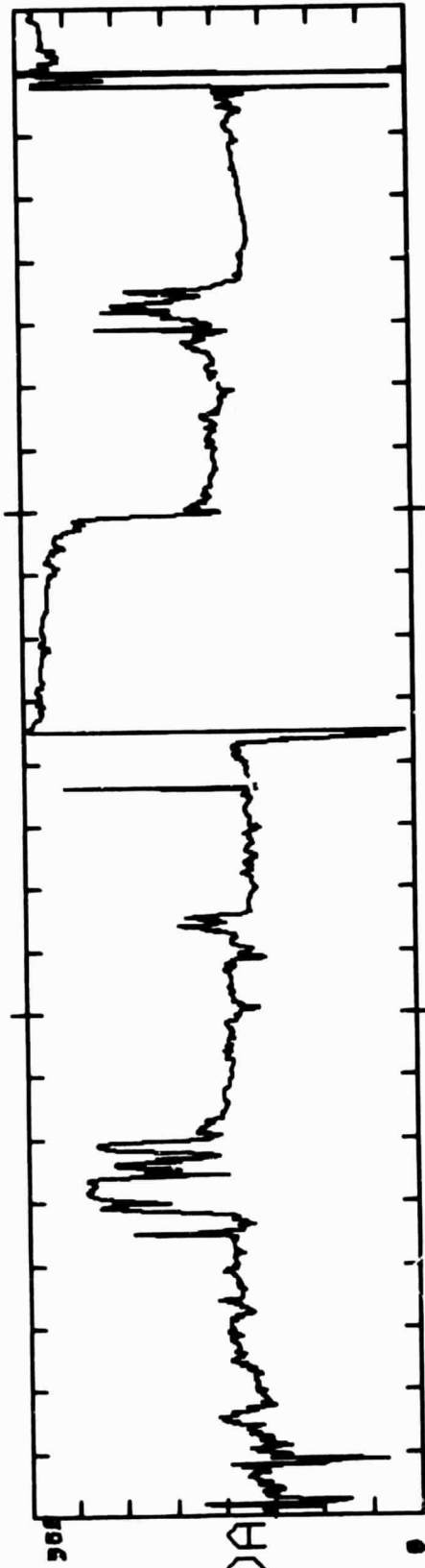
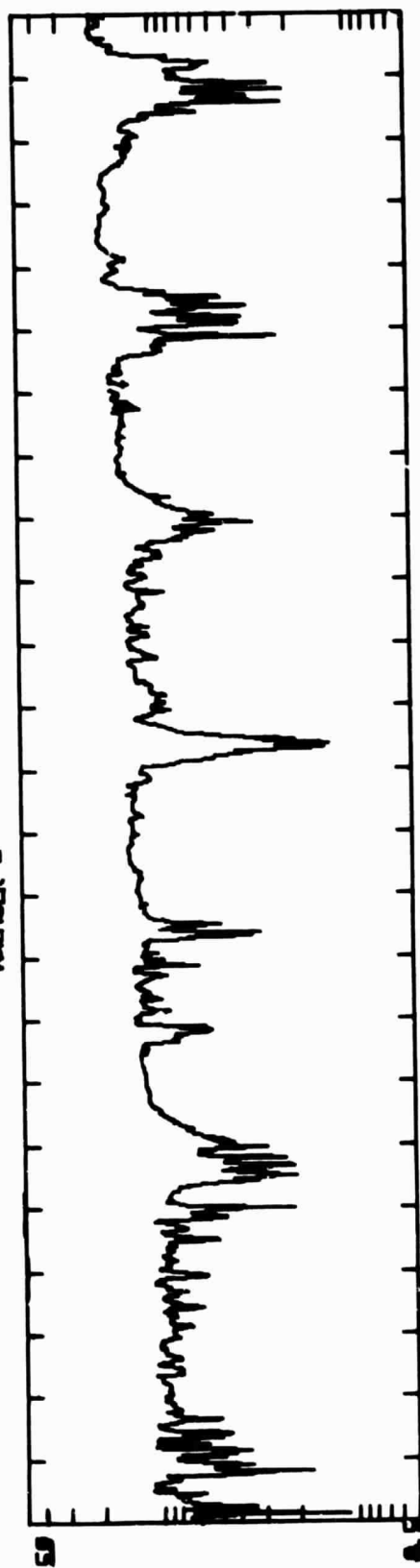
VOYAGER 2



START YEAR +DAY
79 187

6 July

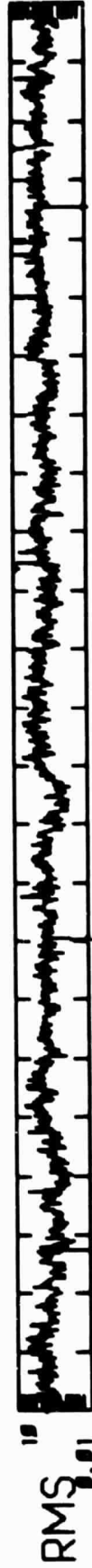
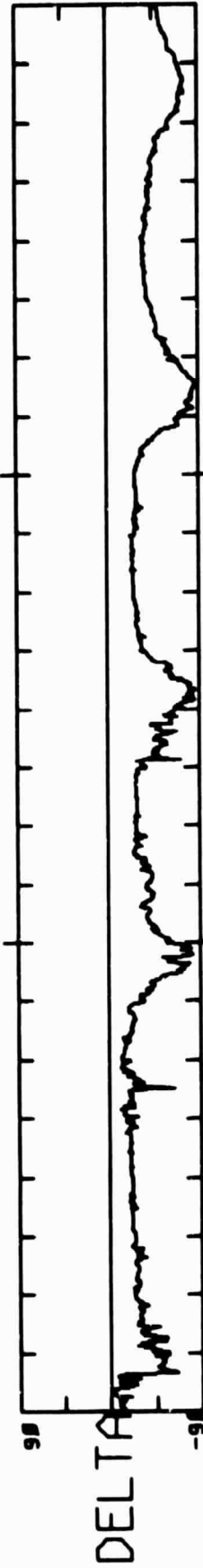
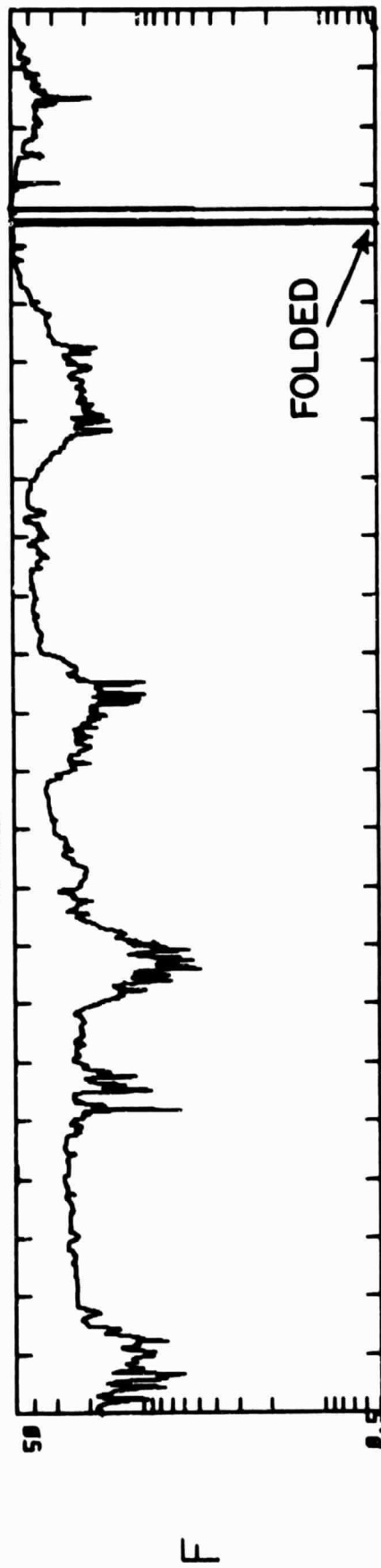
VOLAGER 2



START YEAR +DAY
79 188

7 July

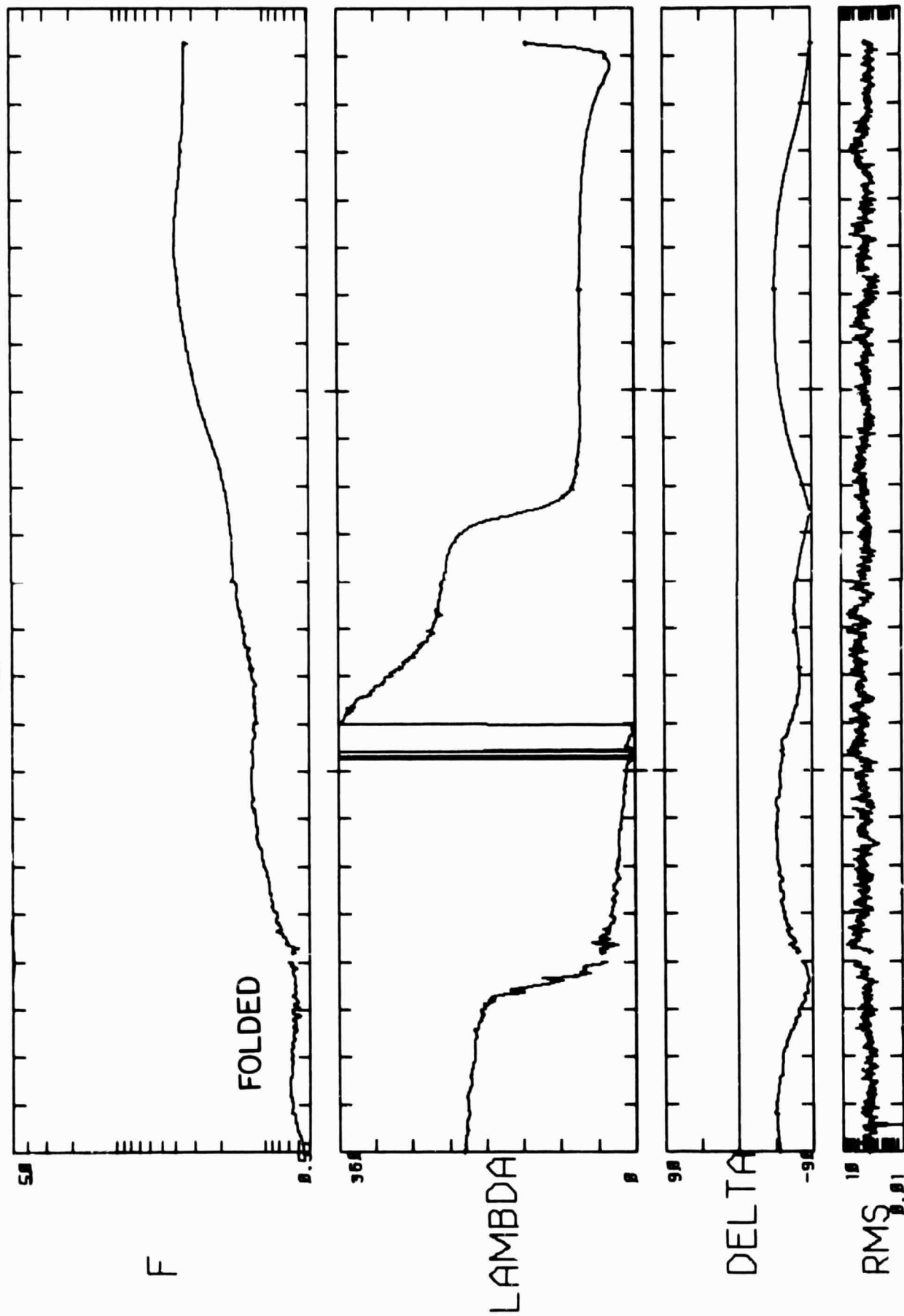
VOYAGER 2



START YEAR +DAY
79 189

8 July

Voyager 2

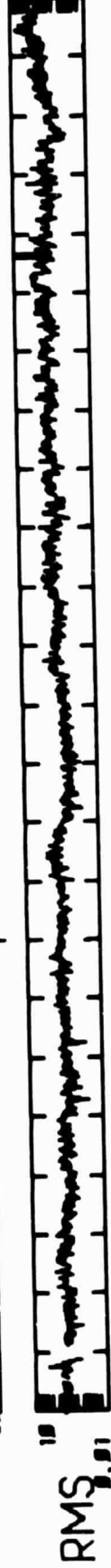
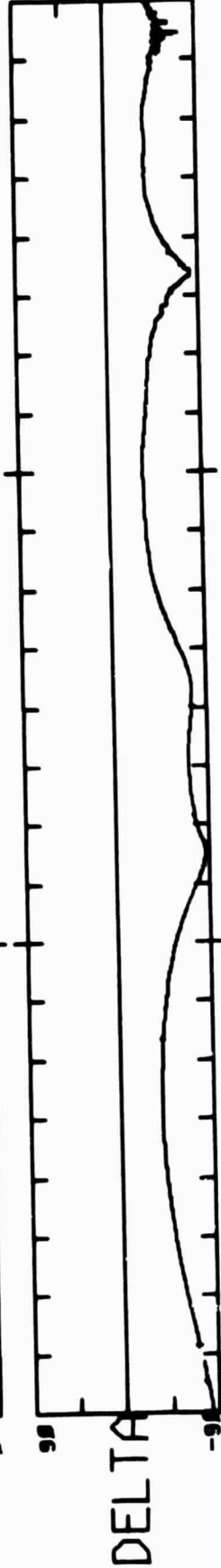
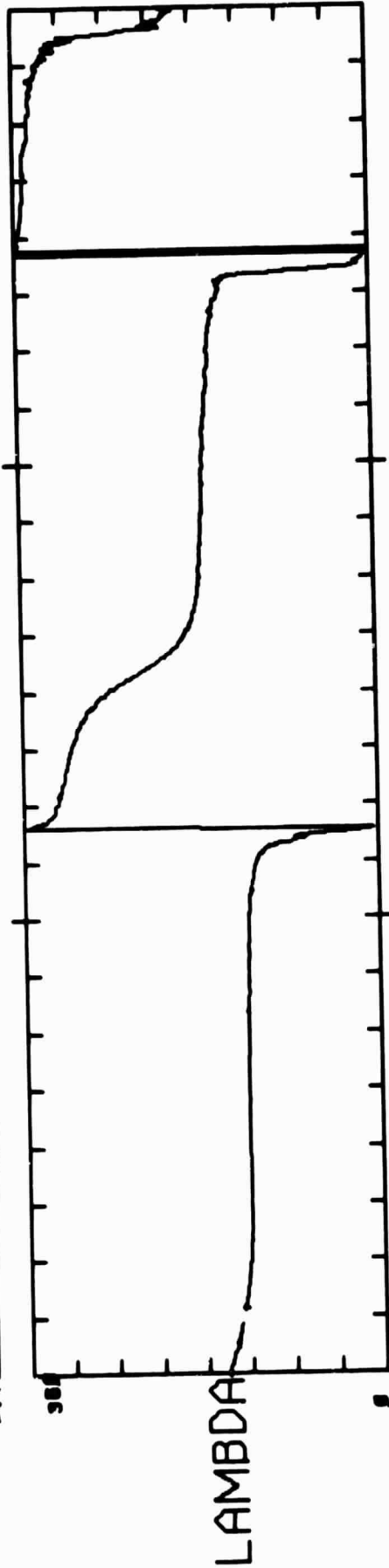
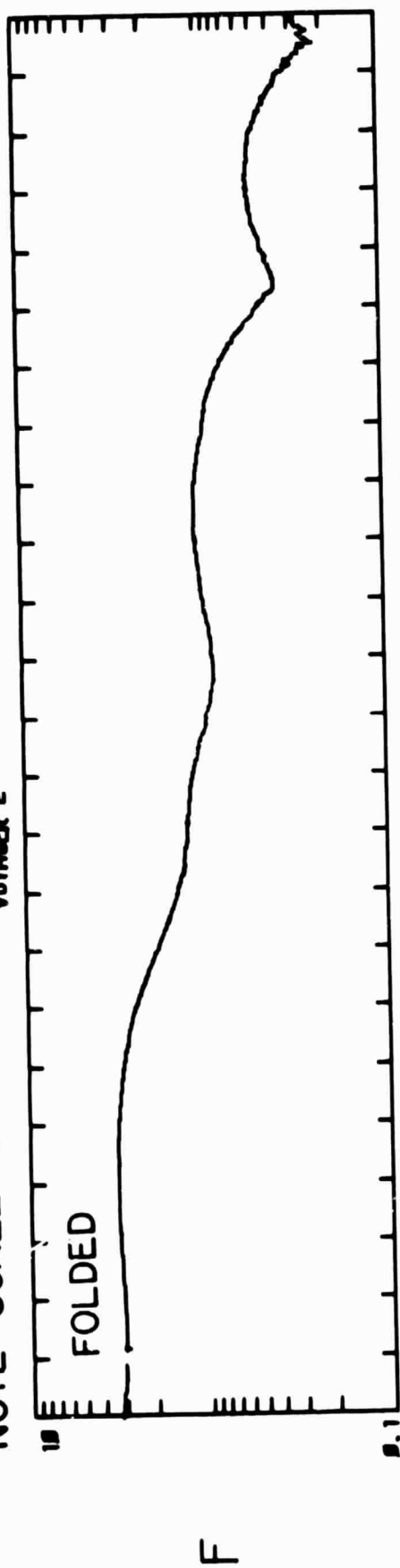


START YEAR +DAY 190

July

NOTE SCALE CHANGE

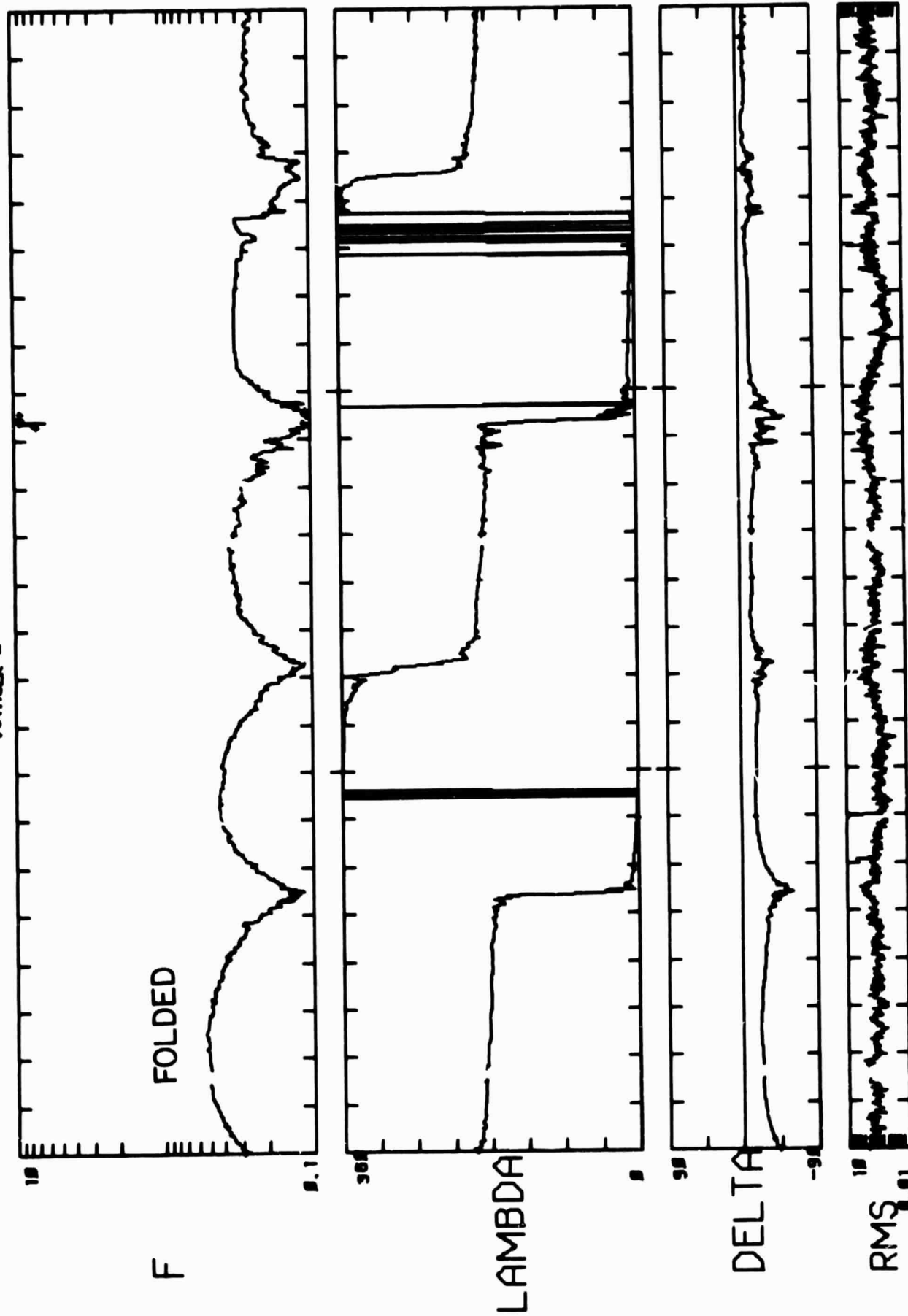
VOYAGER 2



START YEAR +DAY 191

10 July

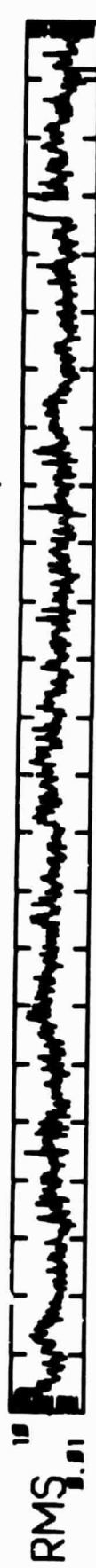
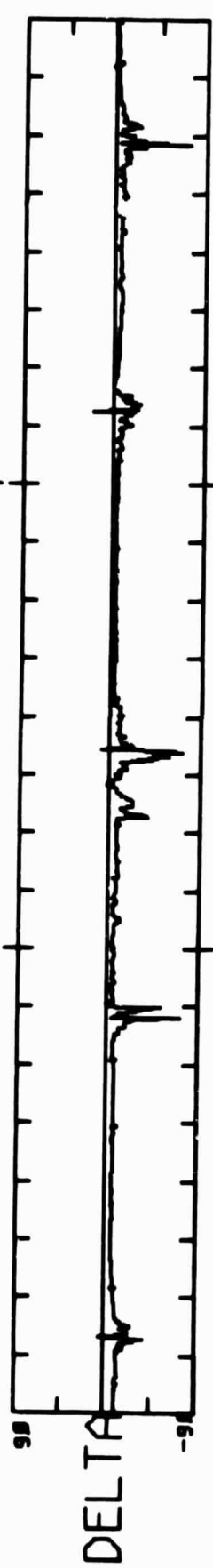
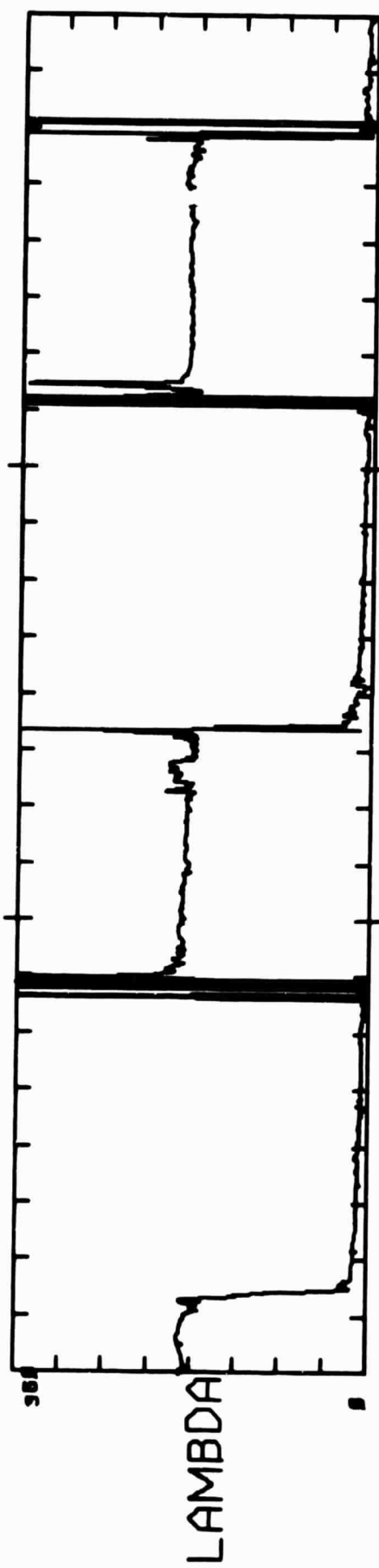
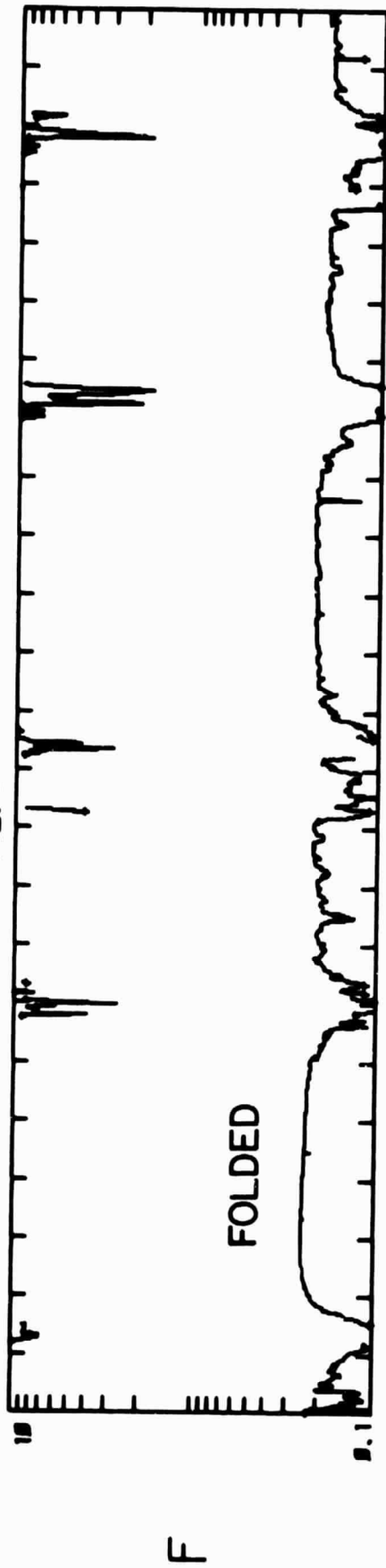
VOYAGER 2



START YEAR +DAY
79 192

11 July

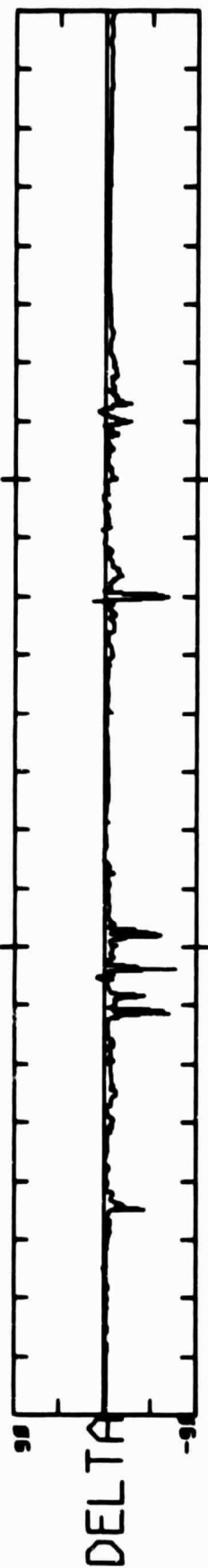
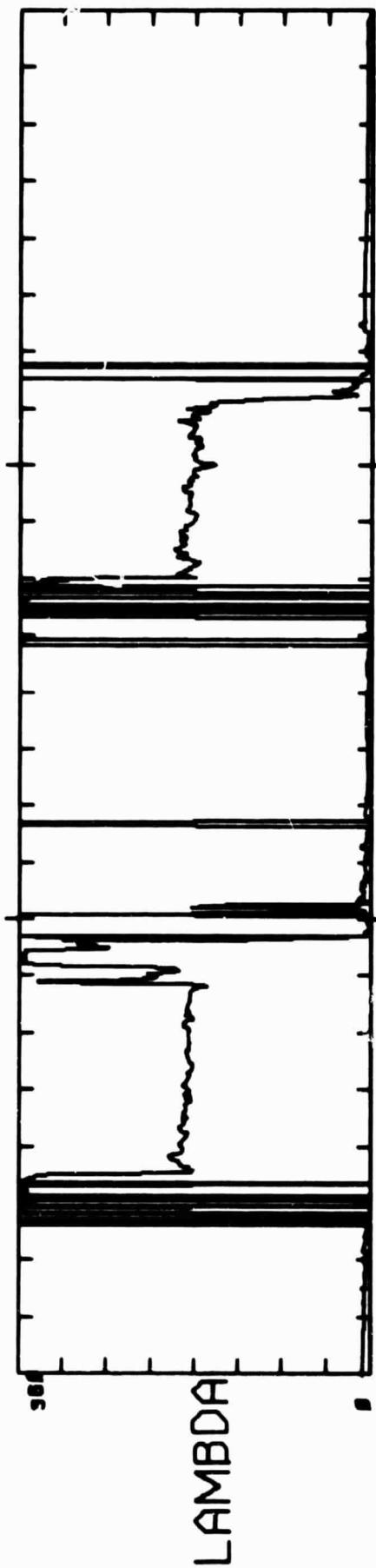
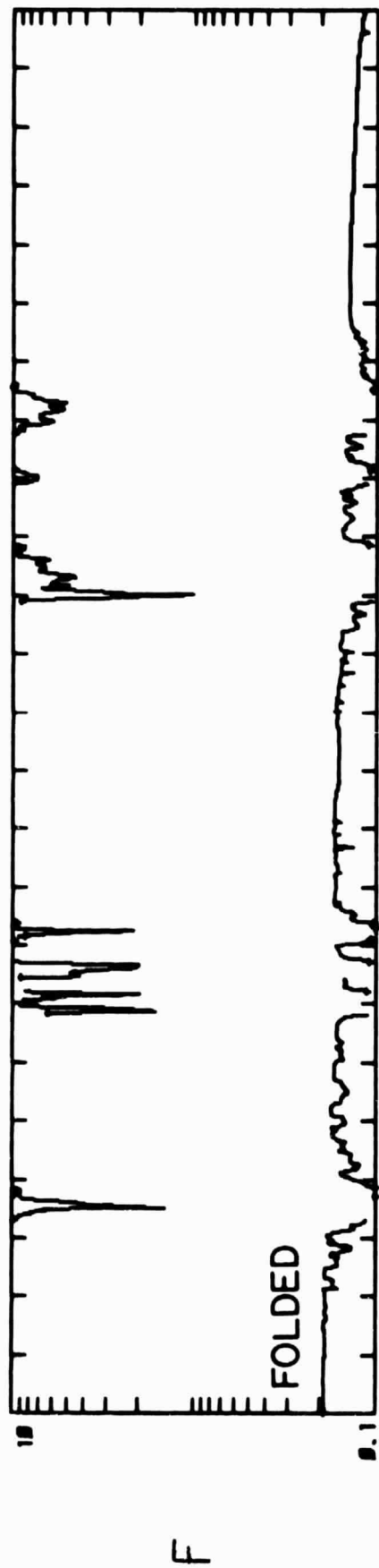
VOYAGER 2



START YEAR +DAY
79 193

12 July

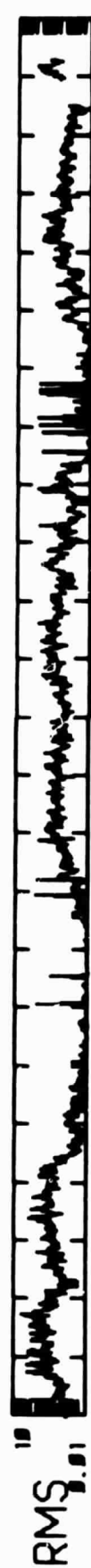
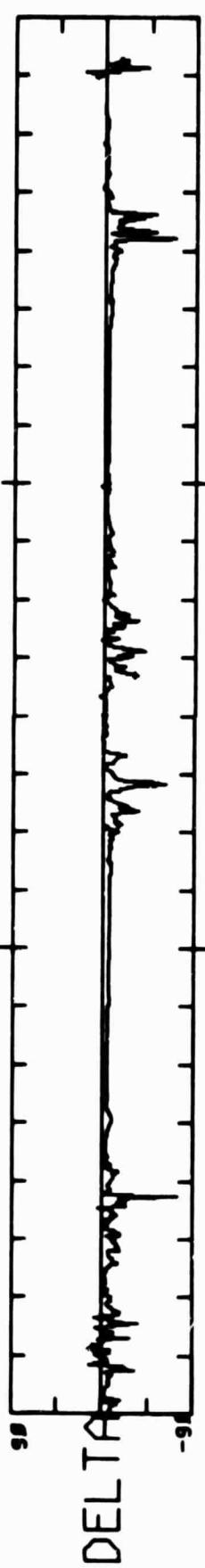
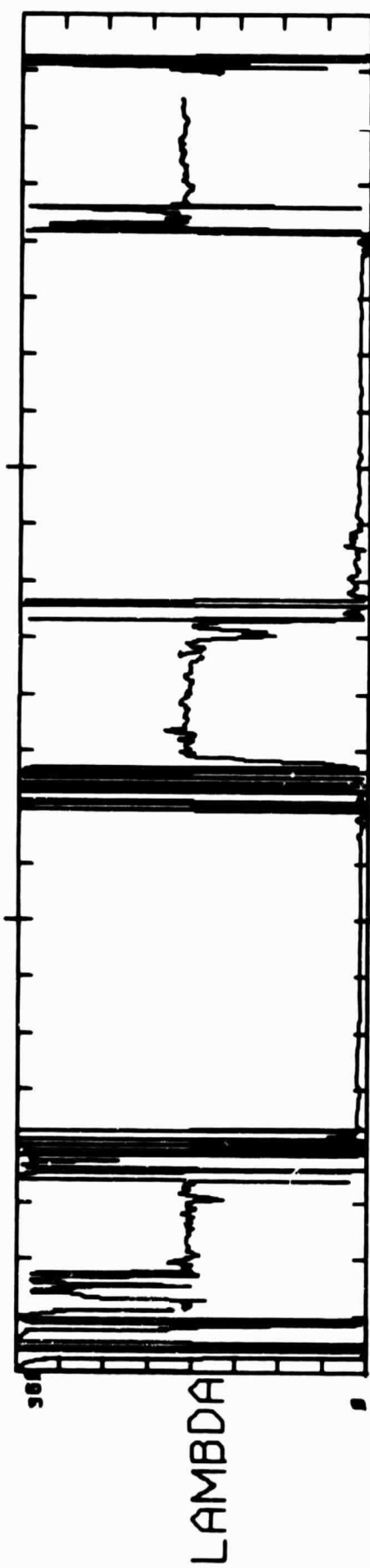
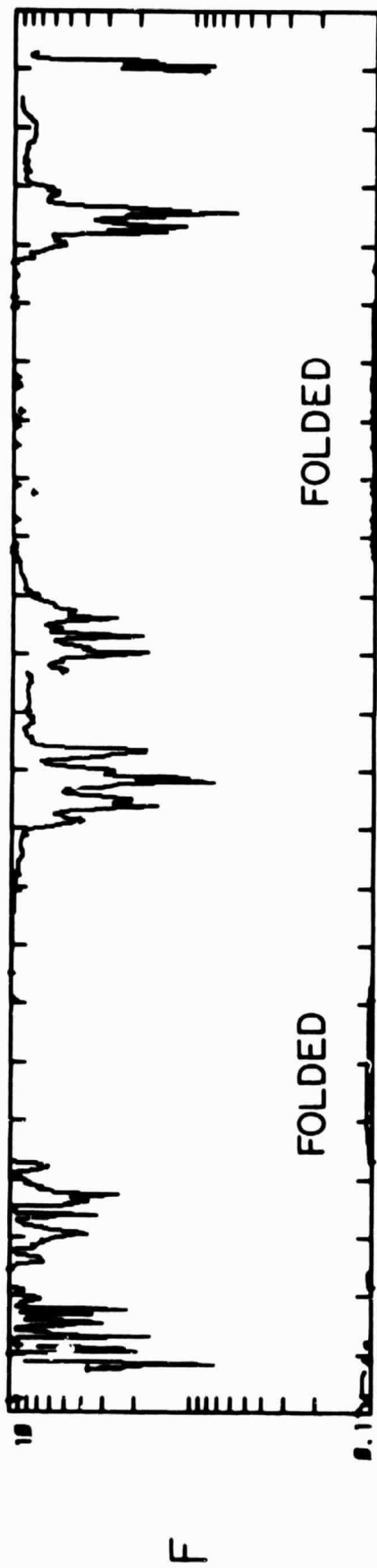
Voyager 2



START YEAR +DAY 79 194

13 July

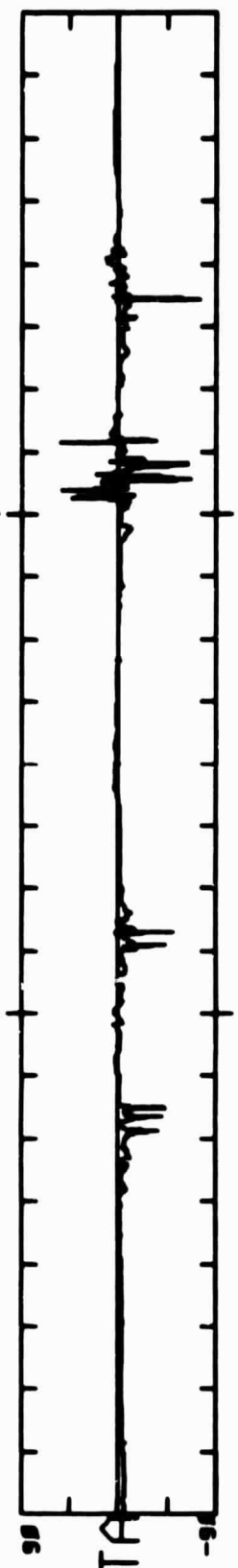
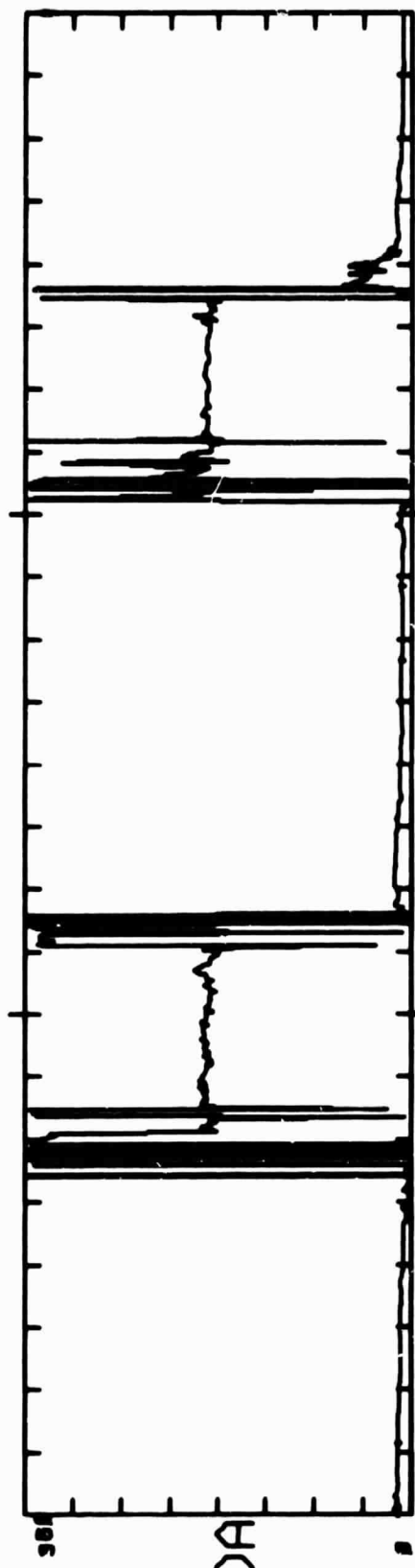
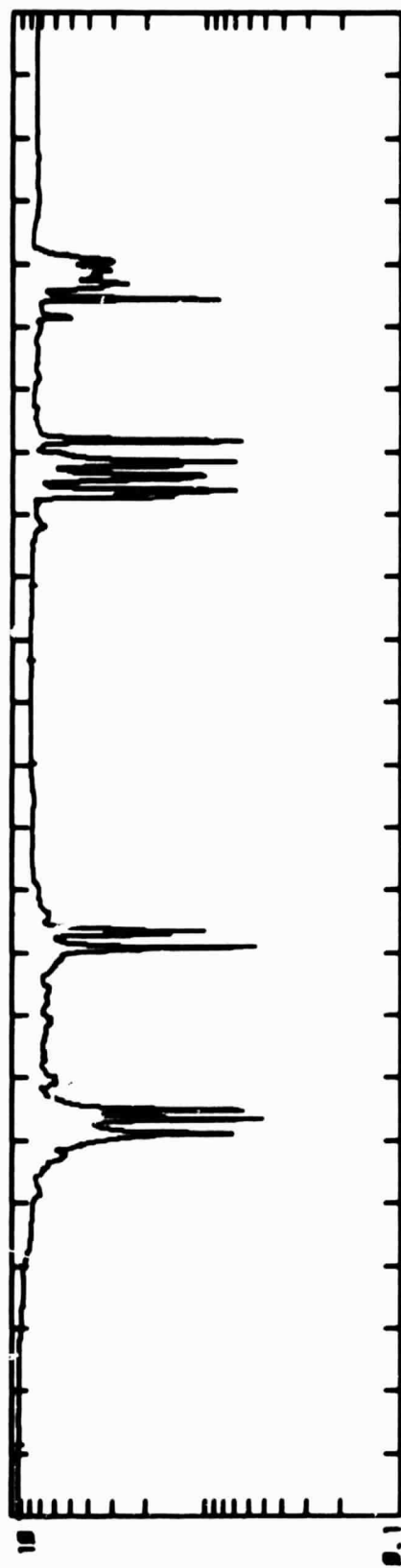
VOYAGER 2



START YEAR +DAY 79 195

14 July

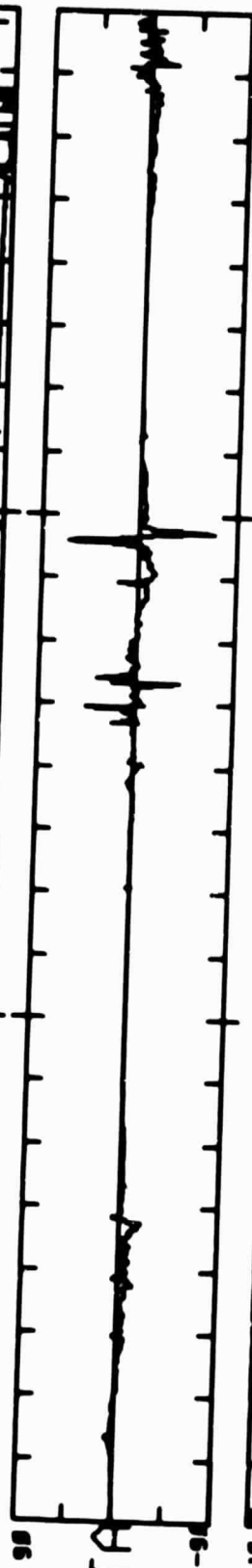
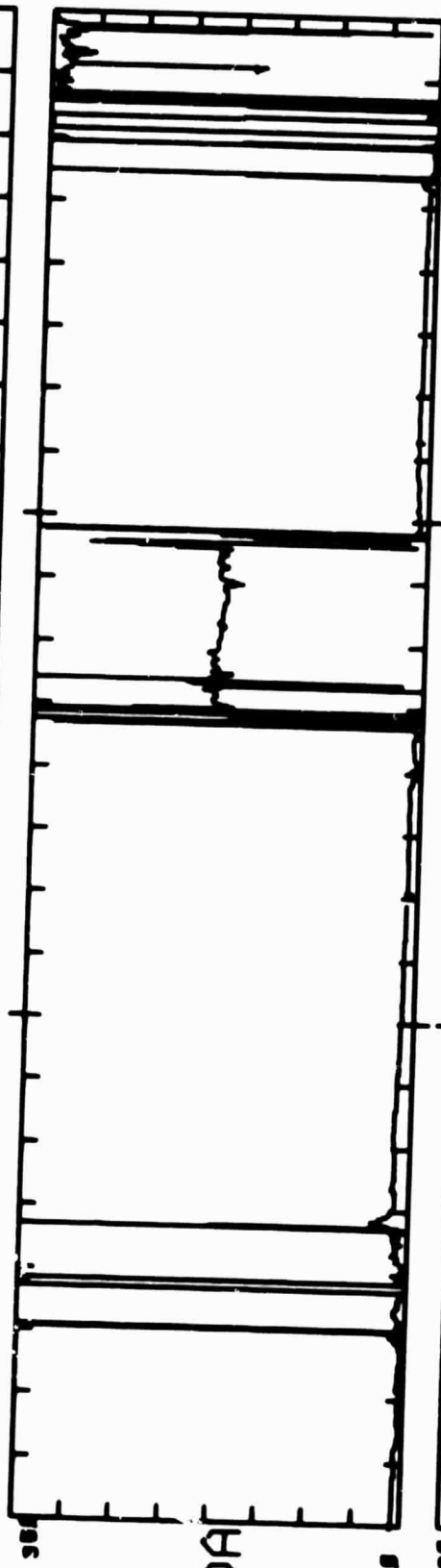
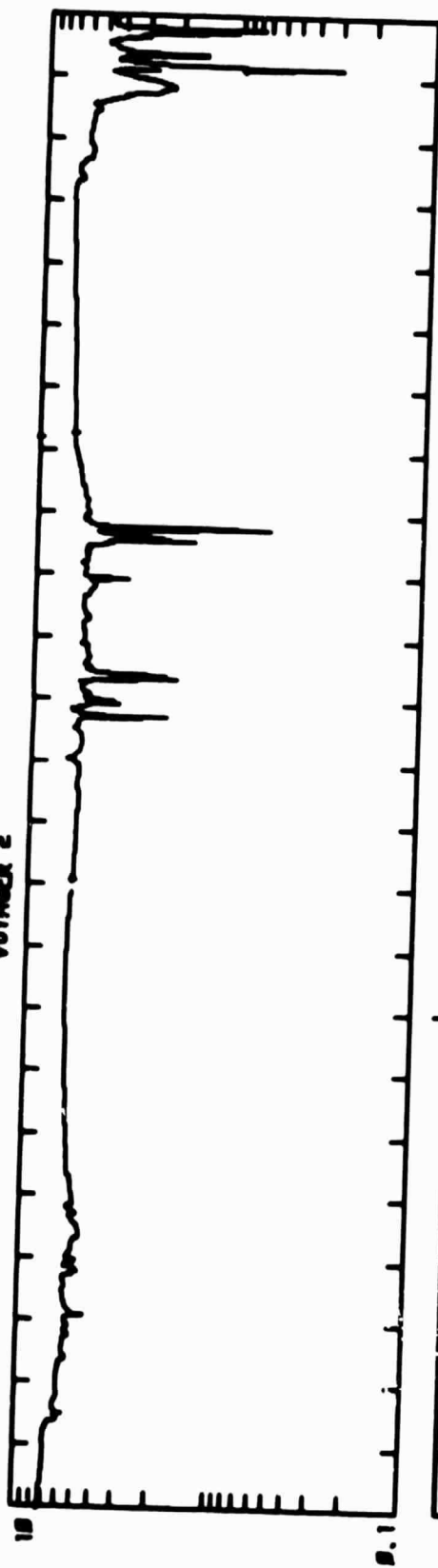
VOYAGER 2



START YEAR +DAY
79 196

15 July

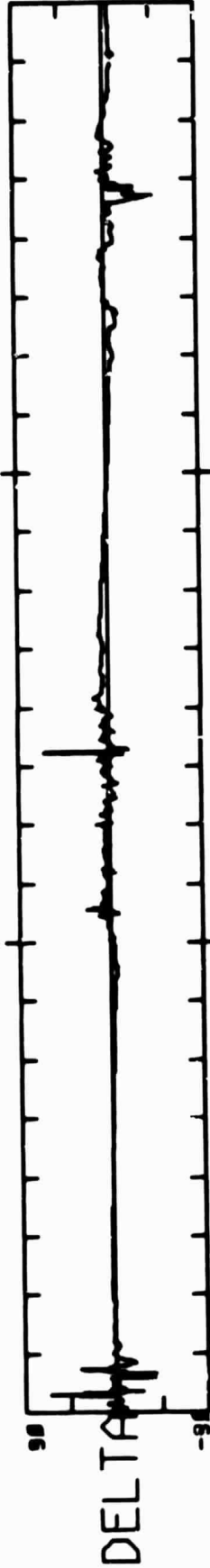
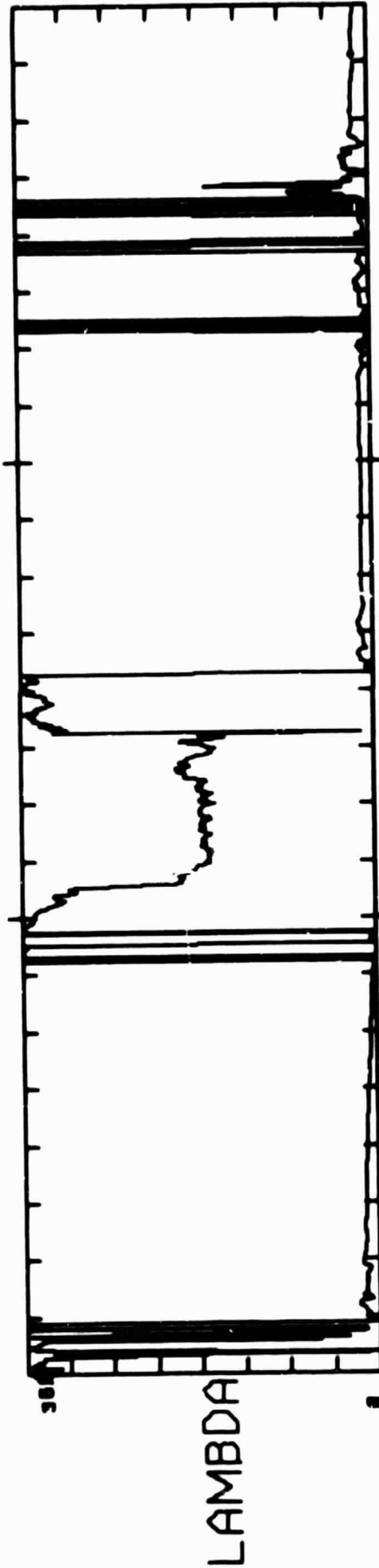
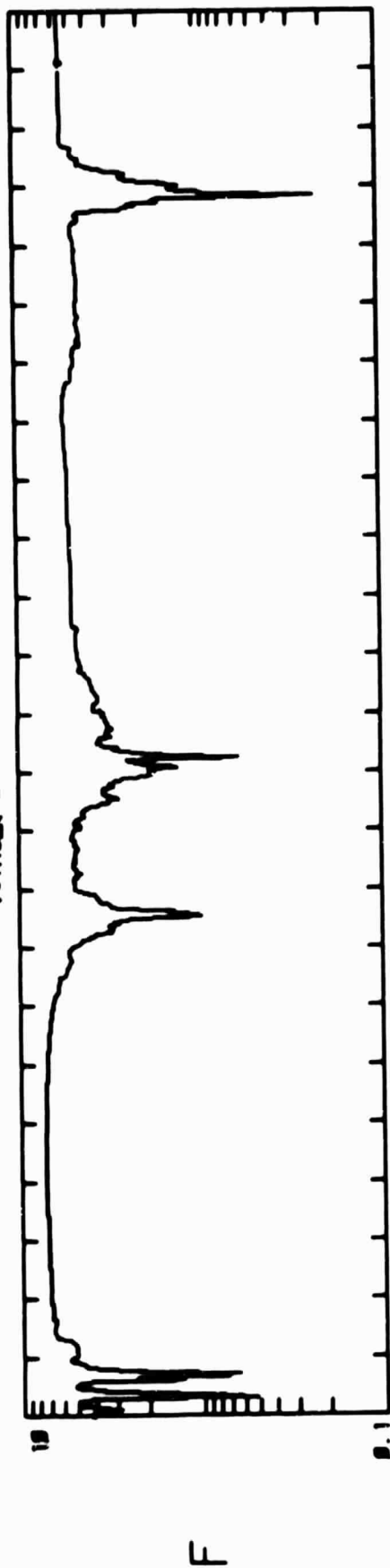
VOYAGER 2



START YEAR + DAY
79 197

16 July

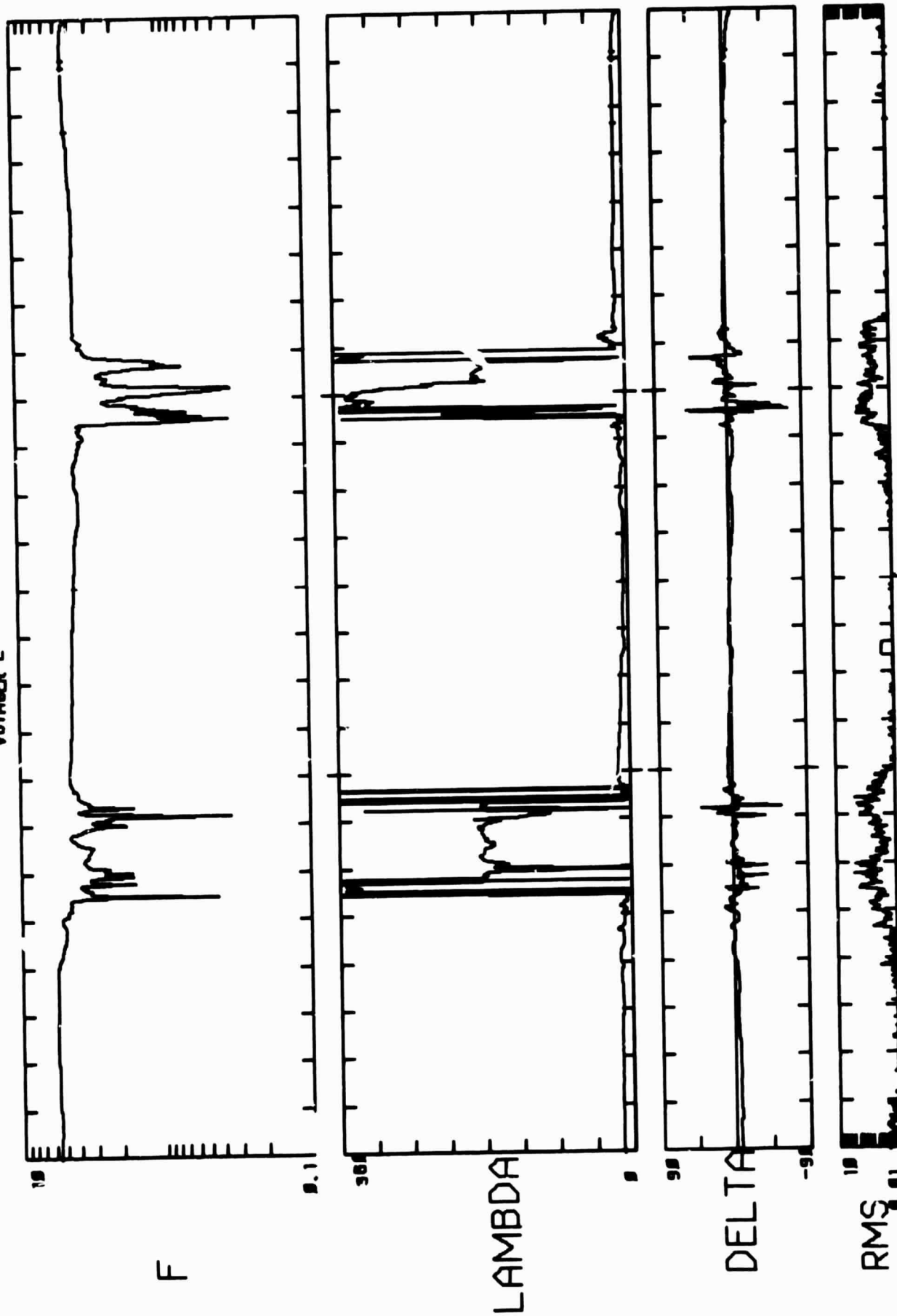
VOTAGER 2



START YEAR +DAY₇₉ 198

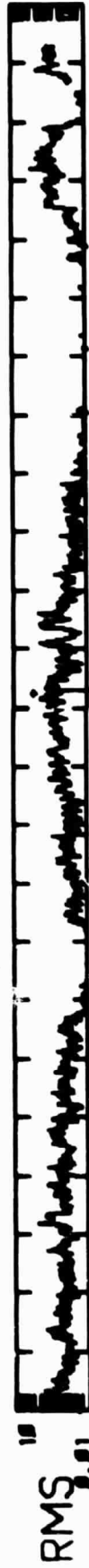
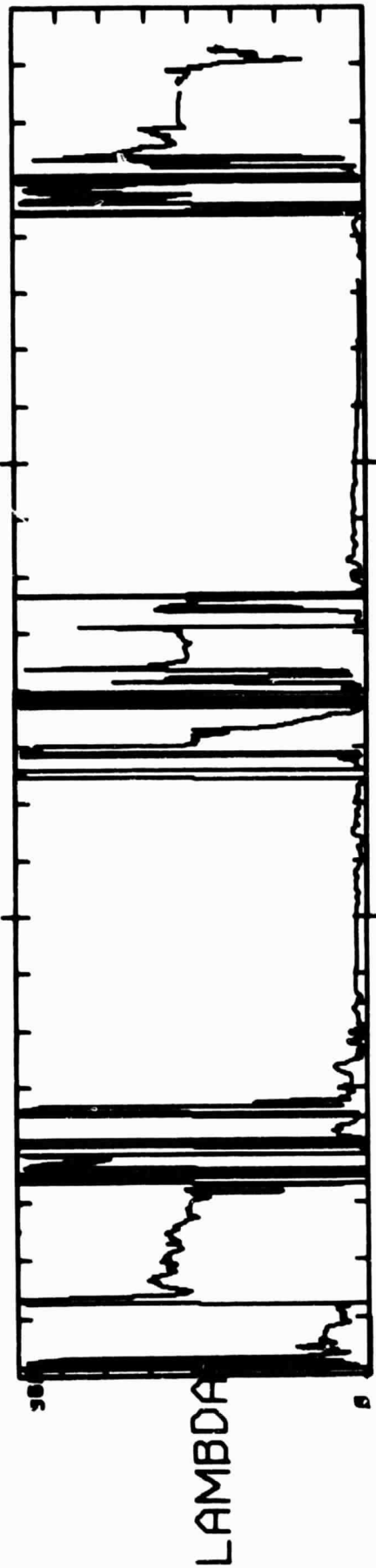
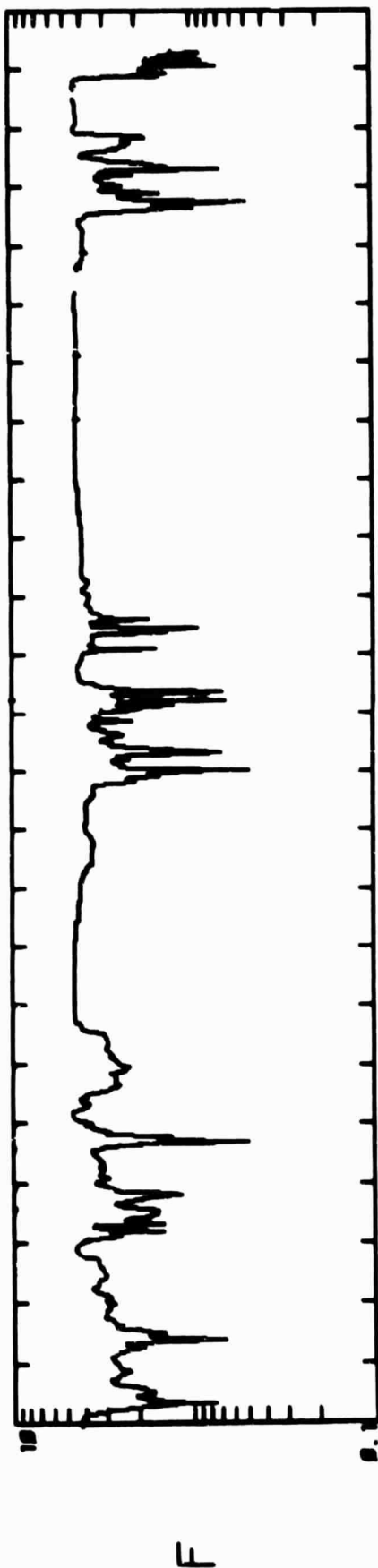
17 July

VOYAGER 2



18 July

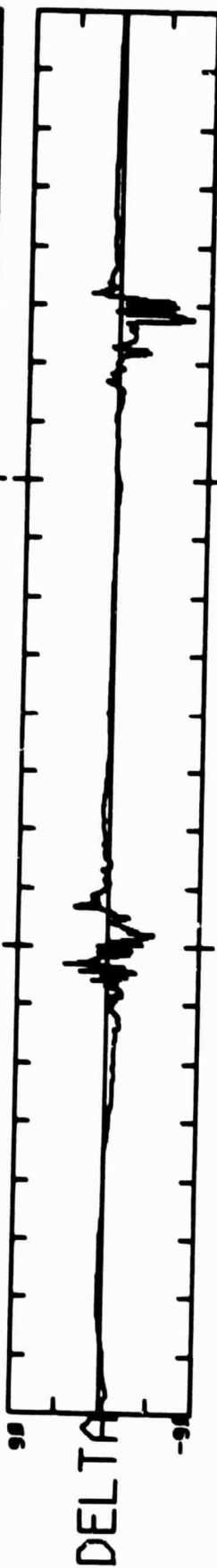
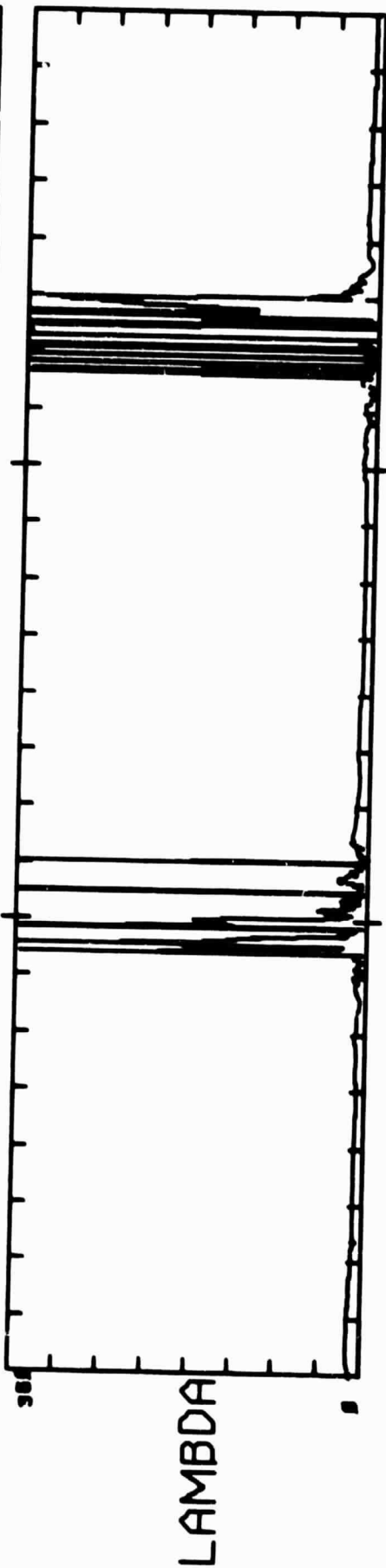
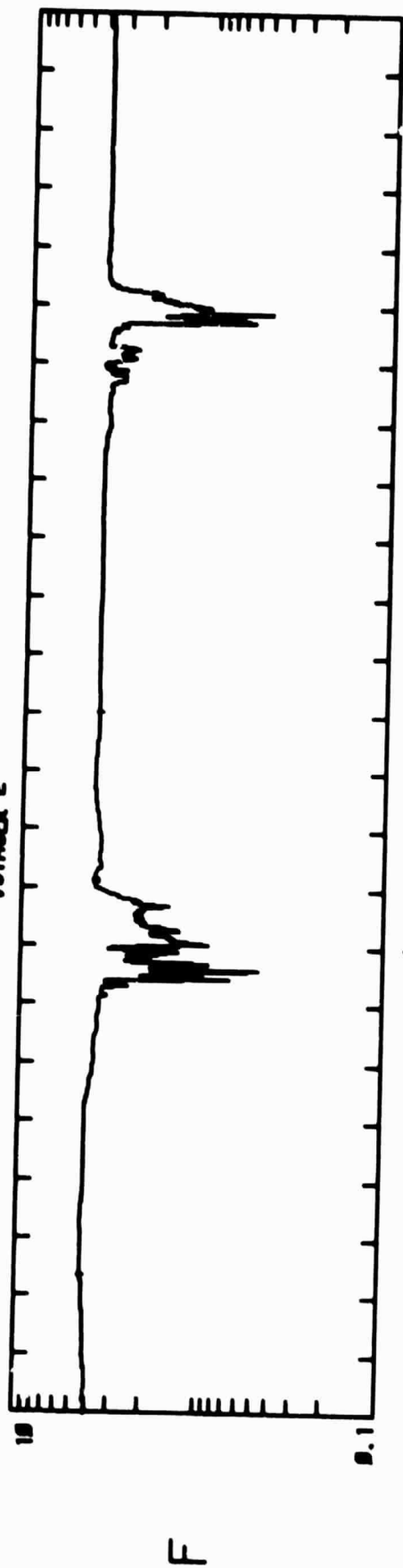
START YEAR +DAY
79 199



START YEAR +DAY 79 200

19 July

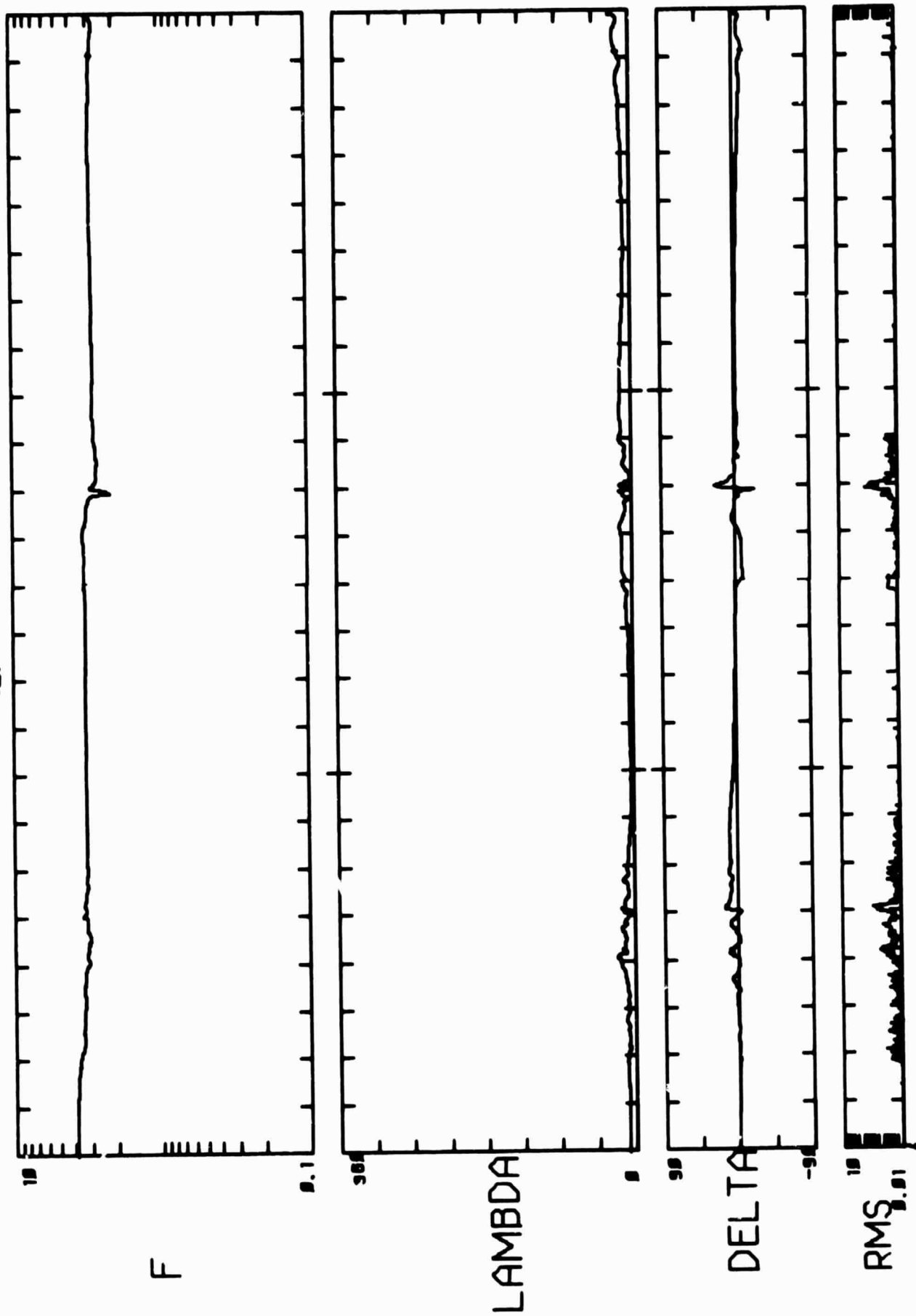
VOTAGER 2



START YEAR +DAY
79 201

20 July

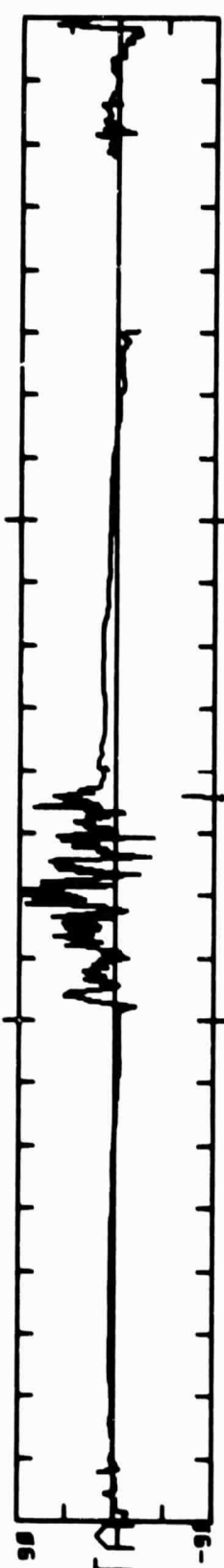
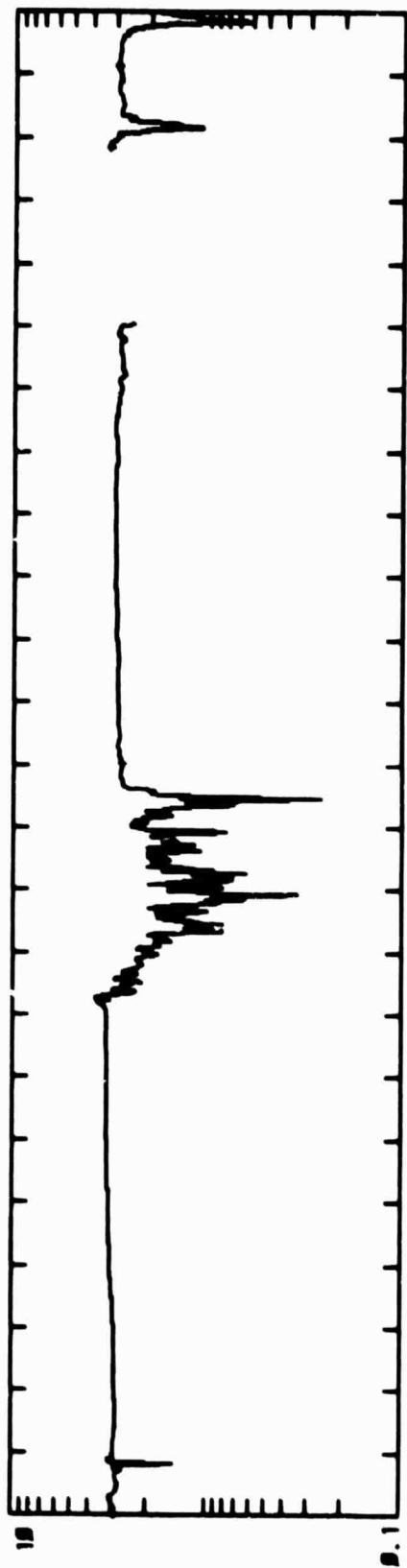
VOYAGER 2



START YEAR +DAY
79 202

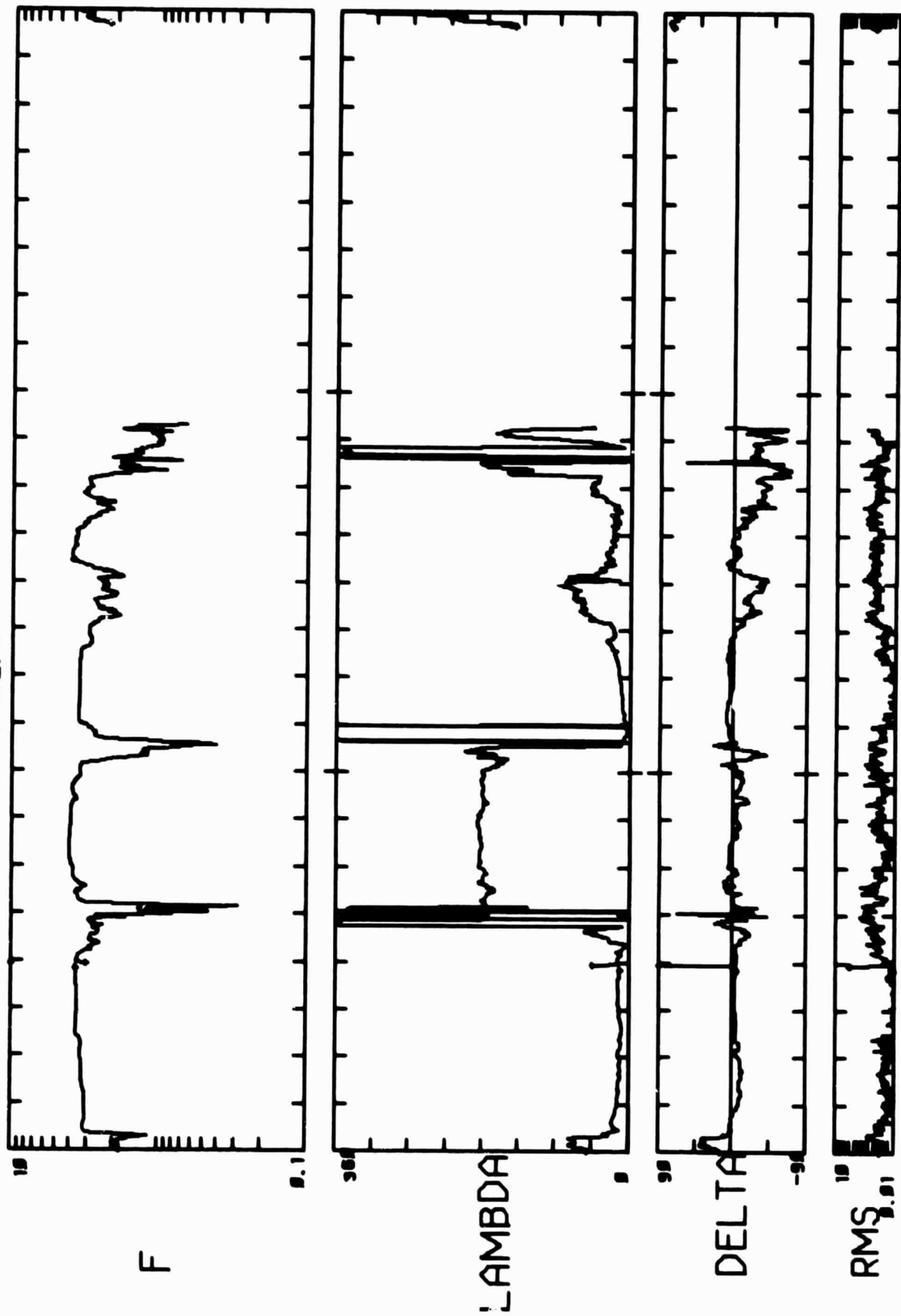
21 July

VOYAGER 2



START YEAR +DAY
79 203

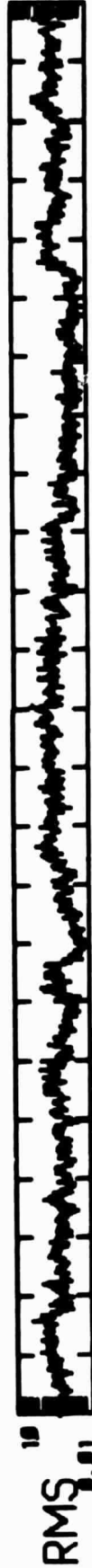
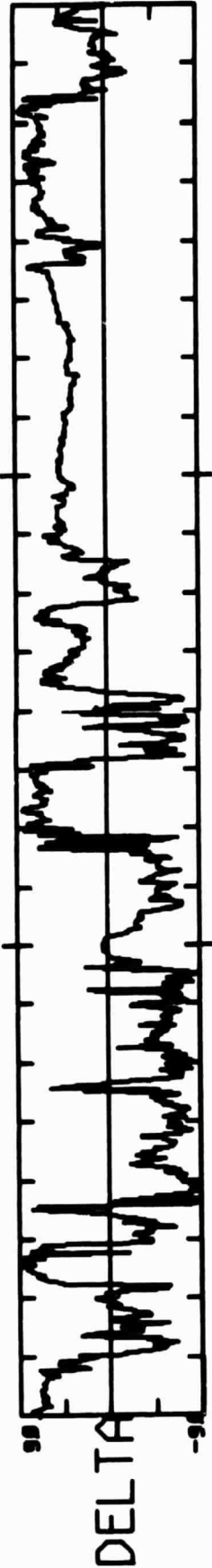
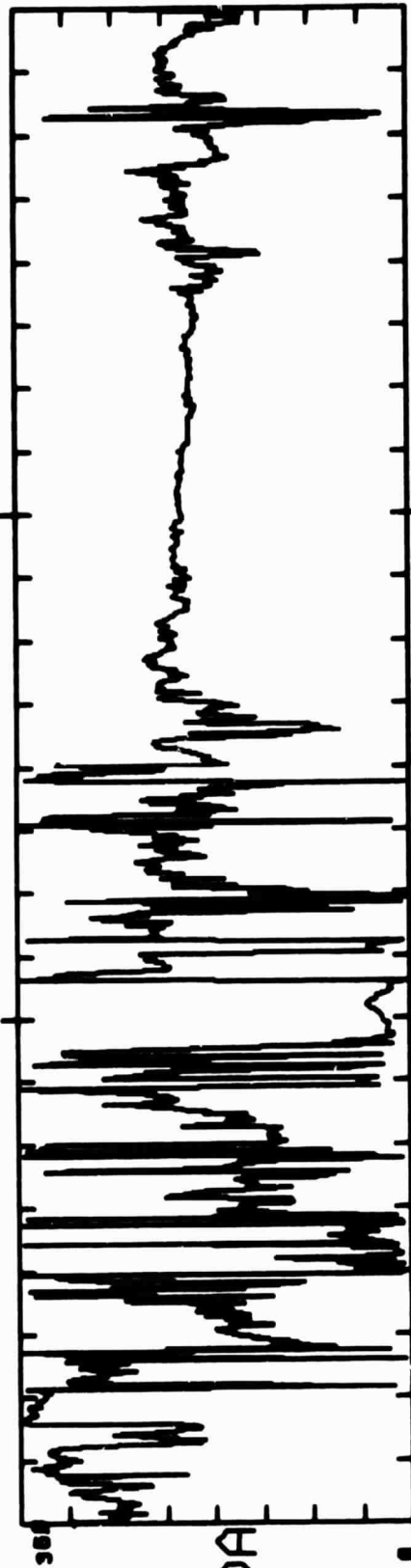
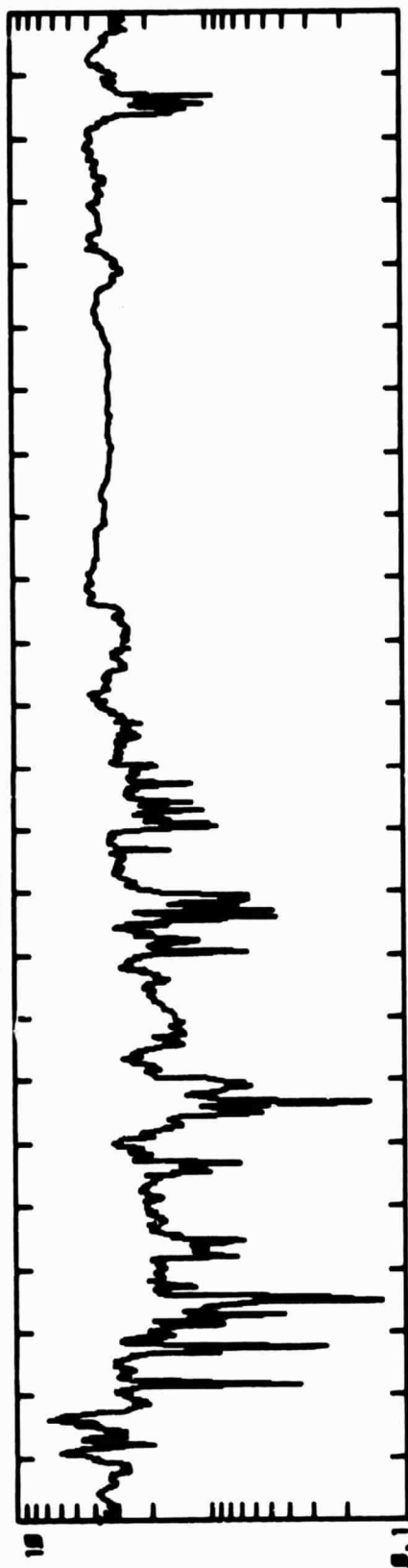
22 July



START YEAR +DAY
79 204

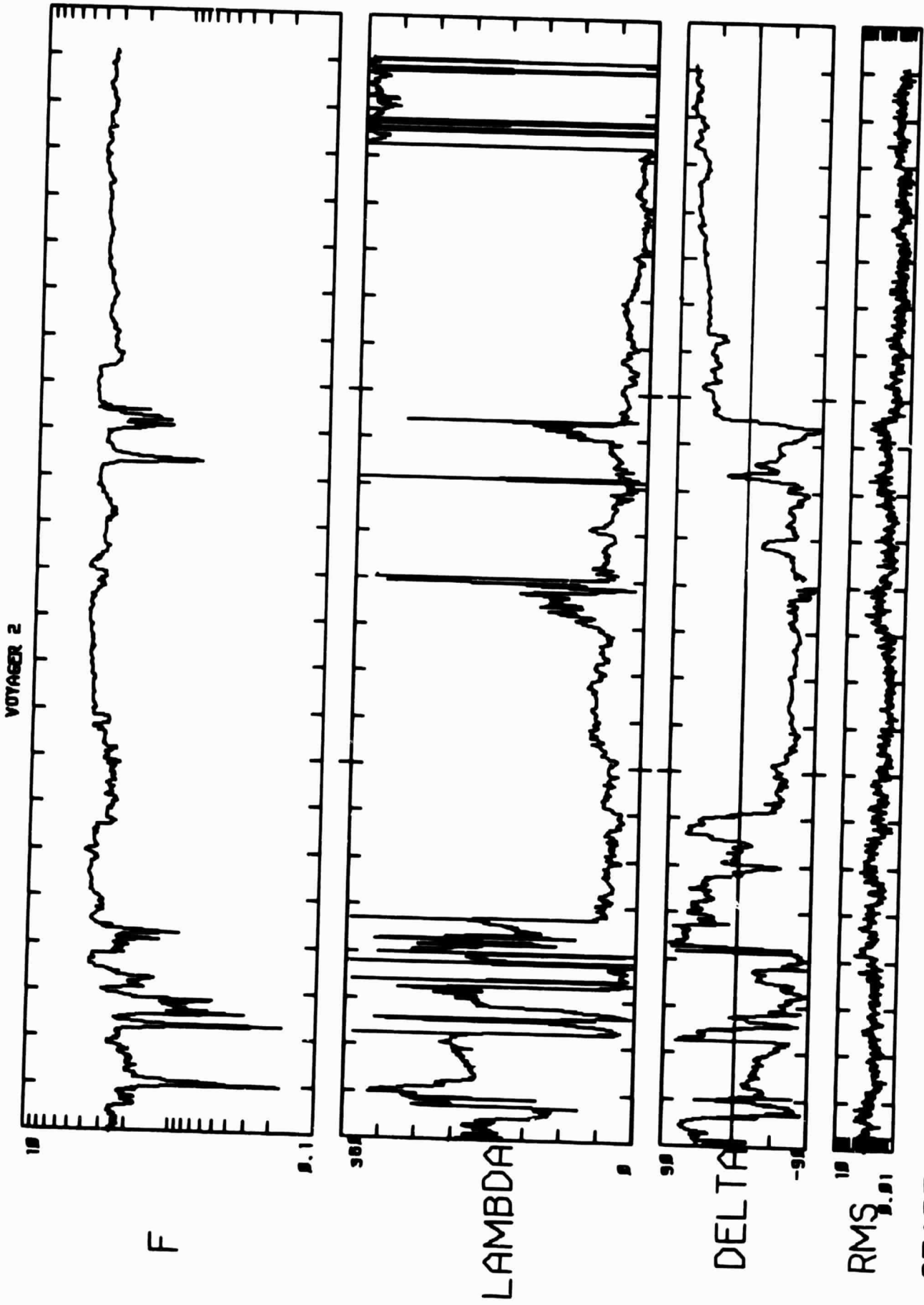
23 July

VOYAGER 2



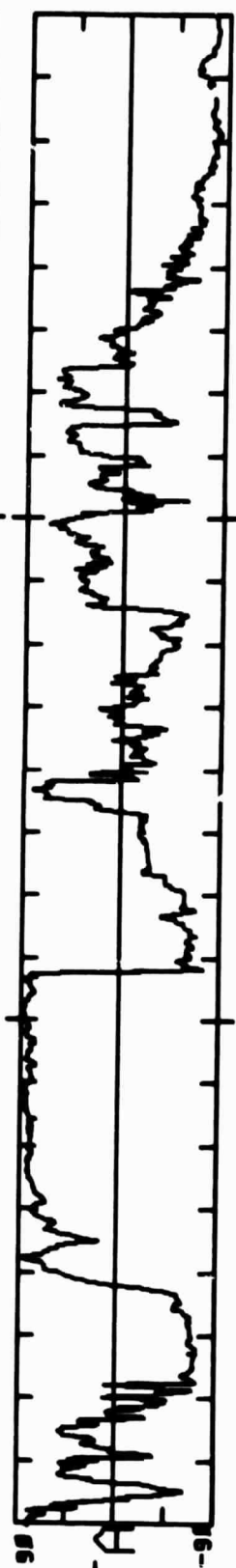
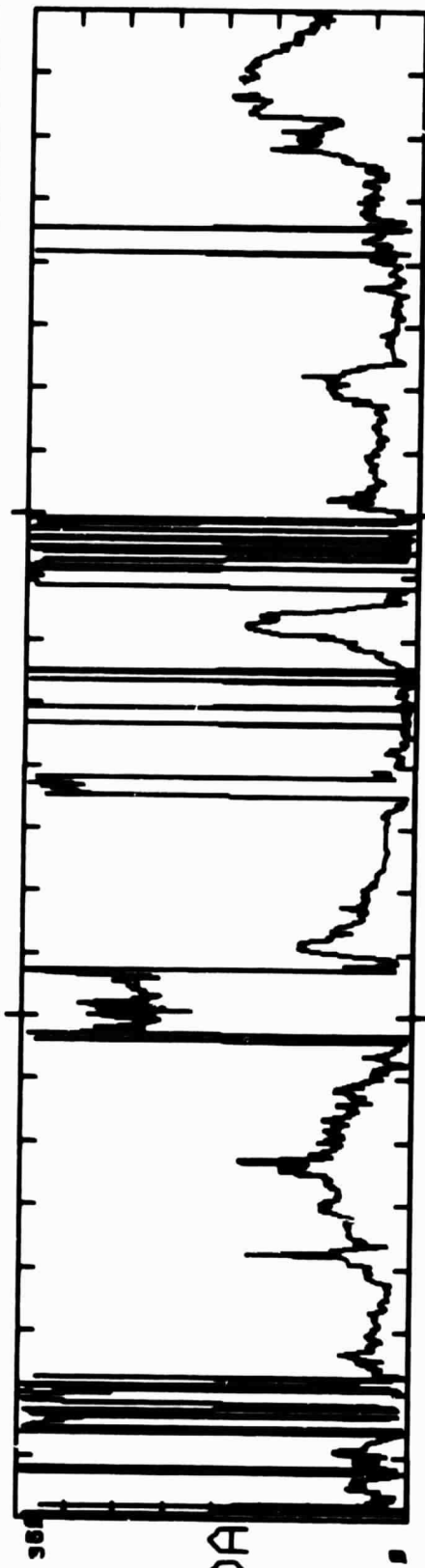
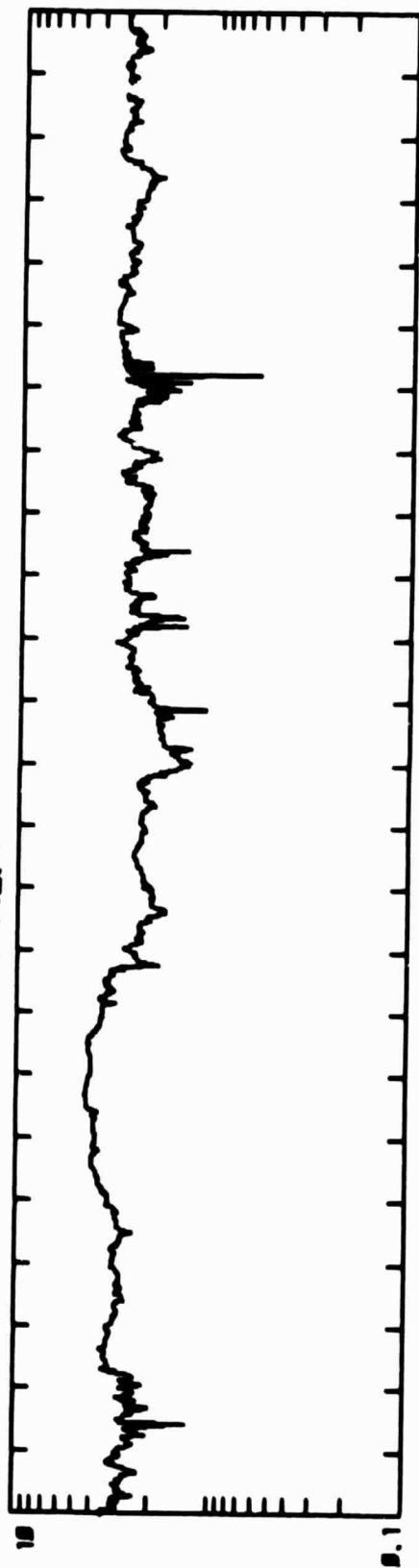
START YEAR +DAY 79 205

24 July



25 July

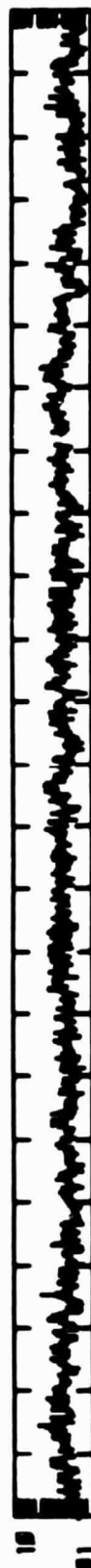
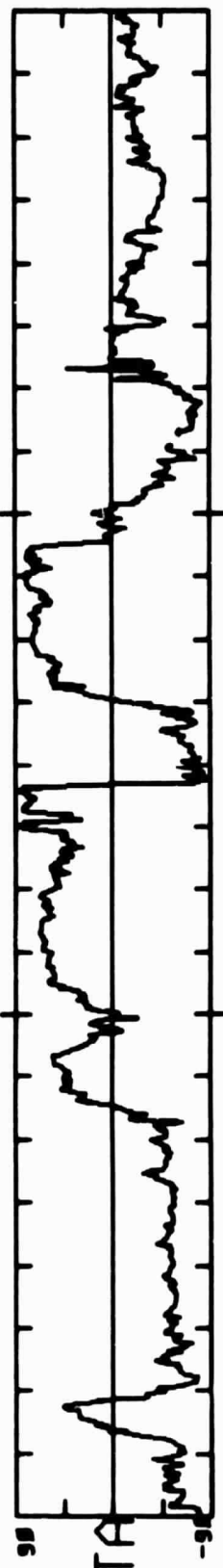
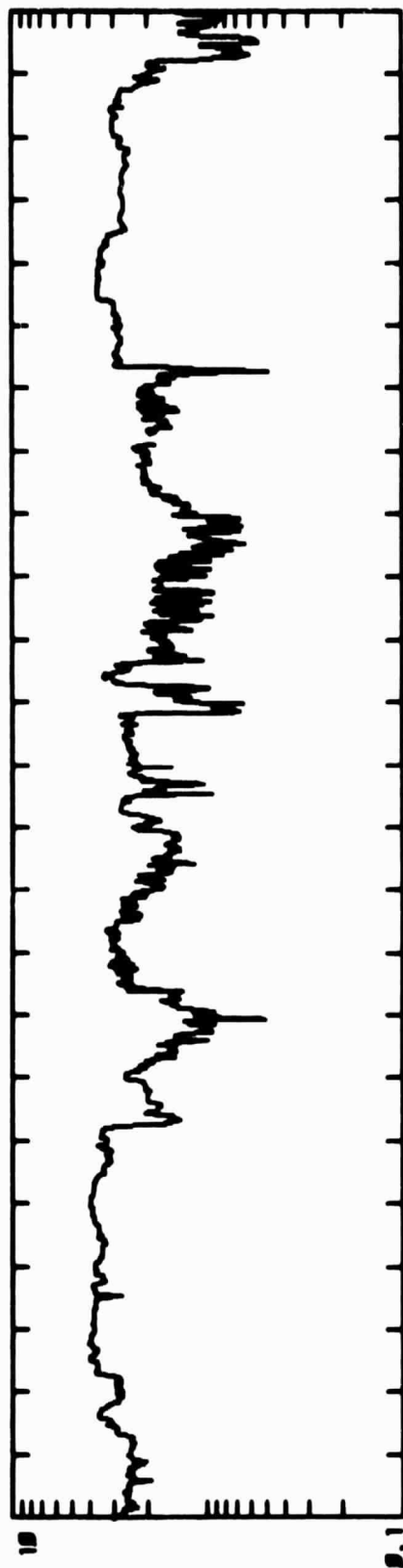
VOYAGER 2



START YEAR +DAY 79 207

26 July

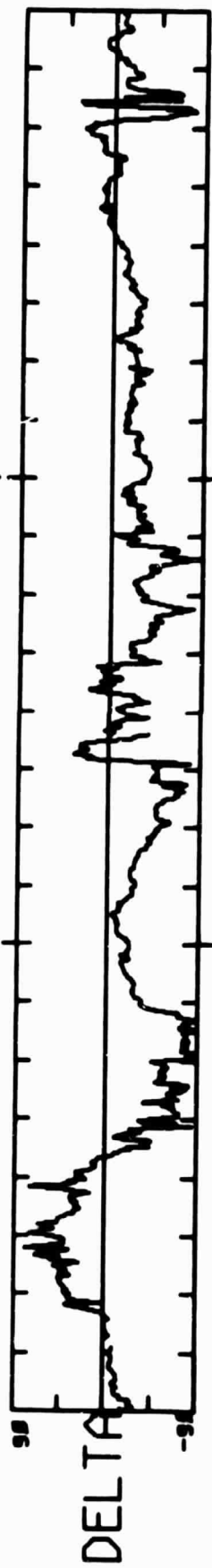
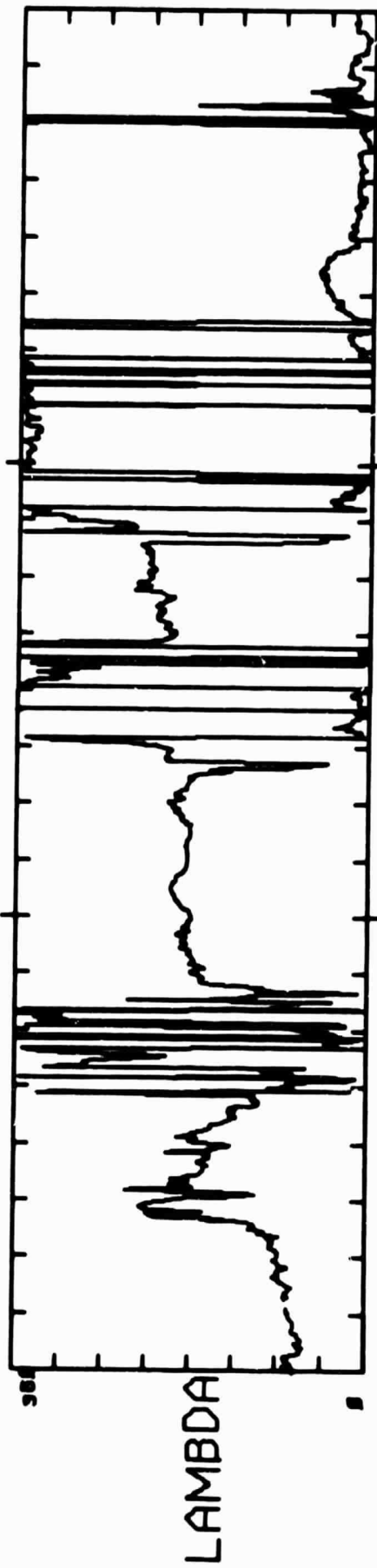
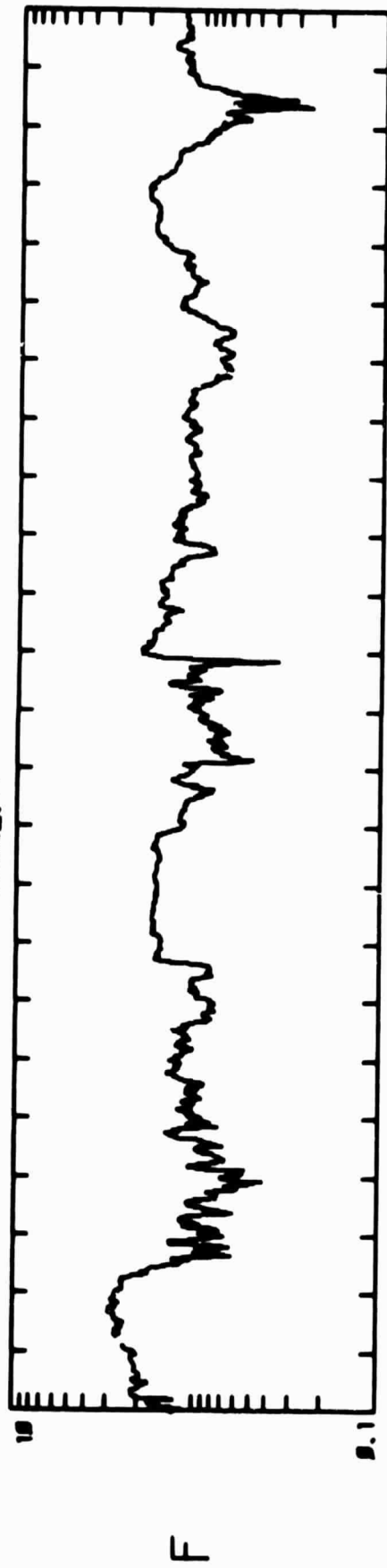
Voyager 2



START YEAR +DAY
79 208

27 July

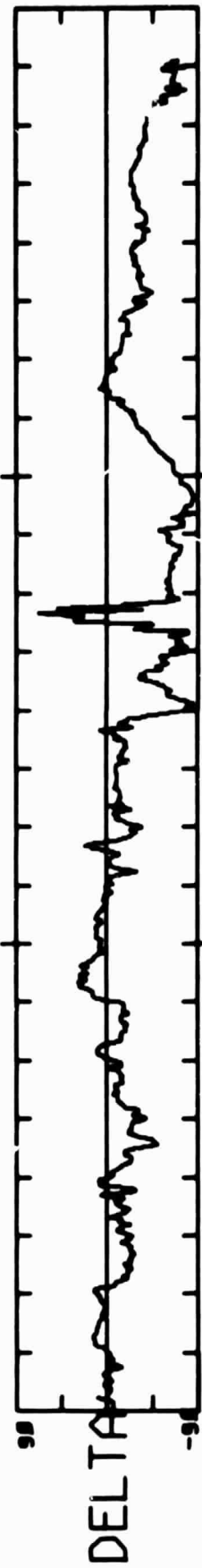
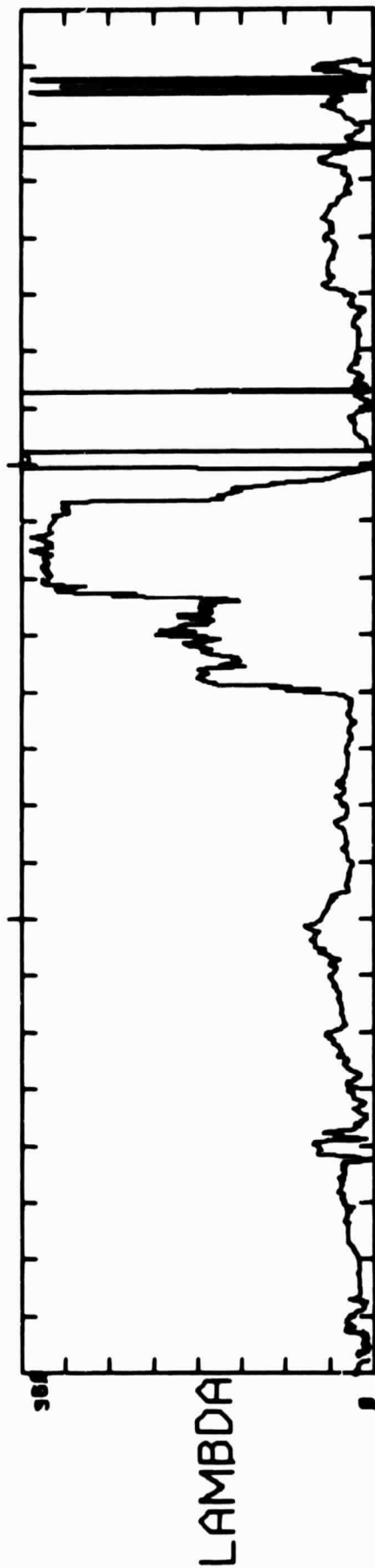
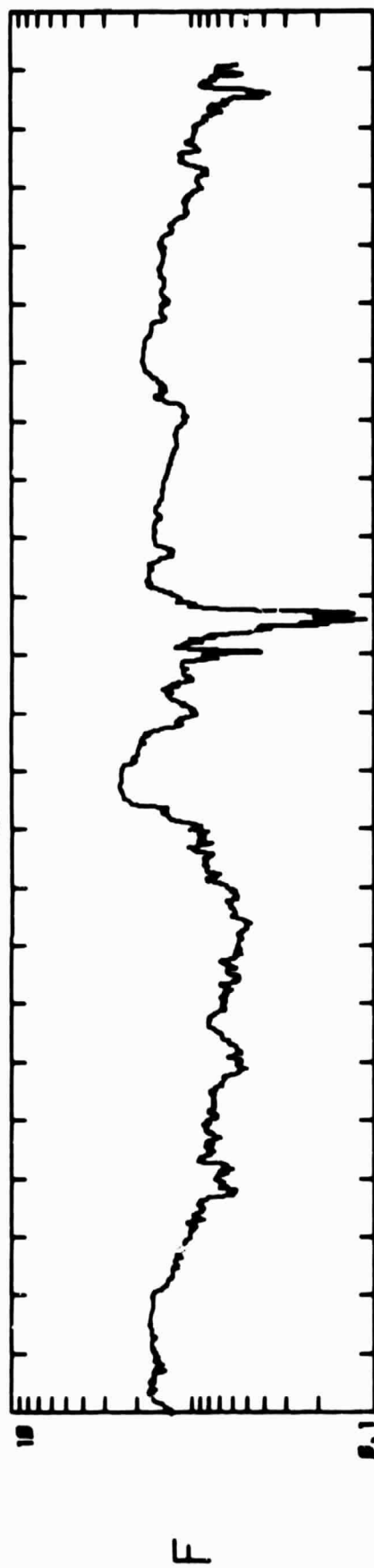
VOTAGER 2



START YEAR +DAY 79 209

28 July

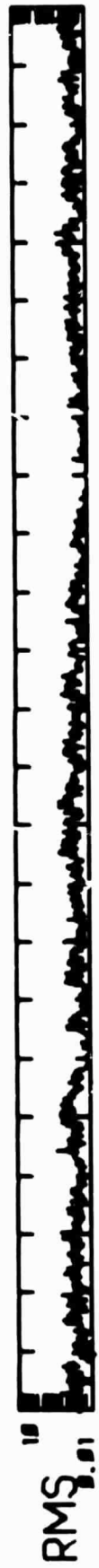
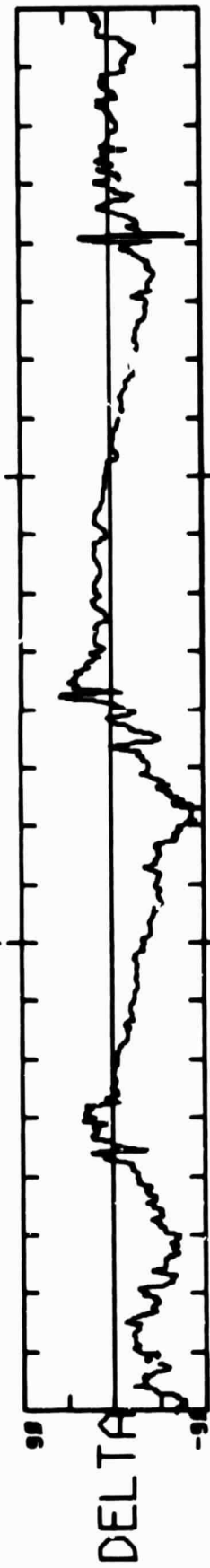
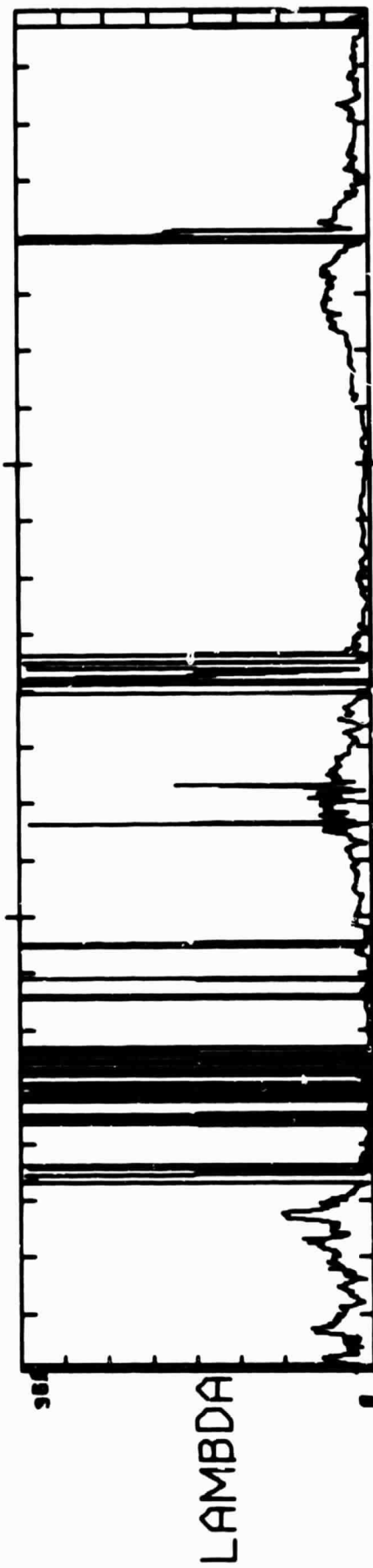
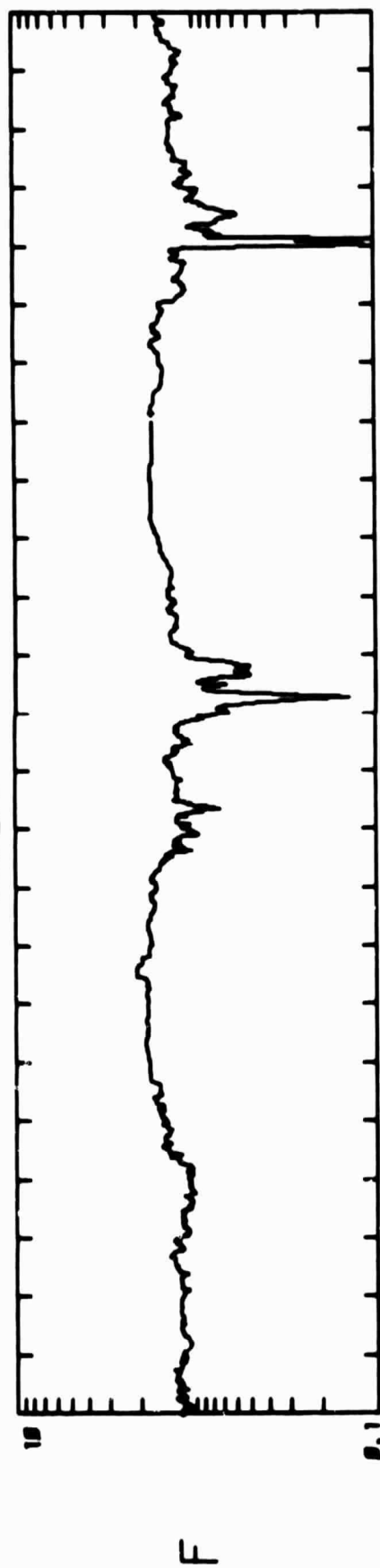
VOTAGER 2



START YEAR +DAY 79 210

29 July

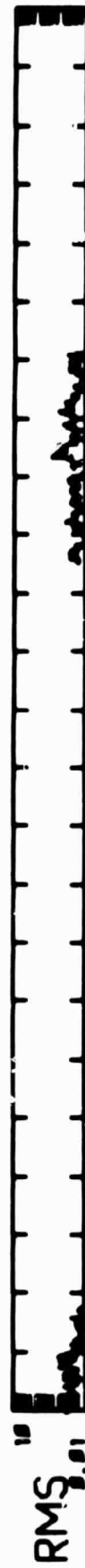
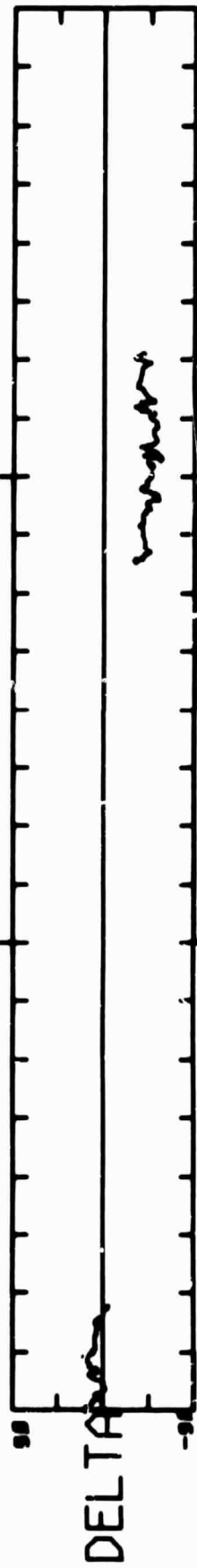
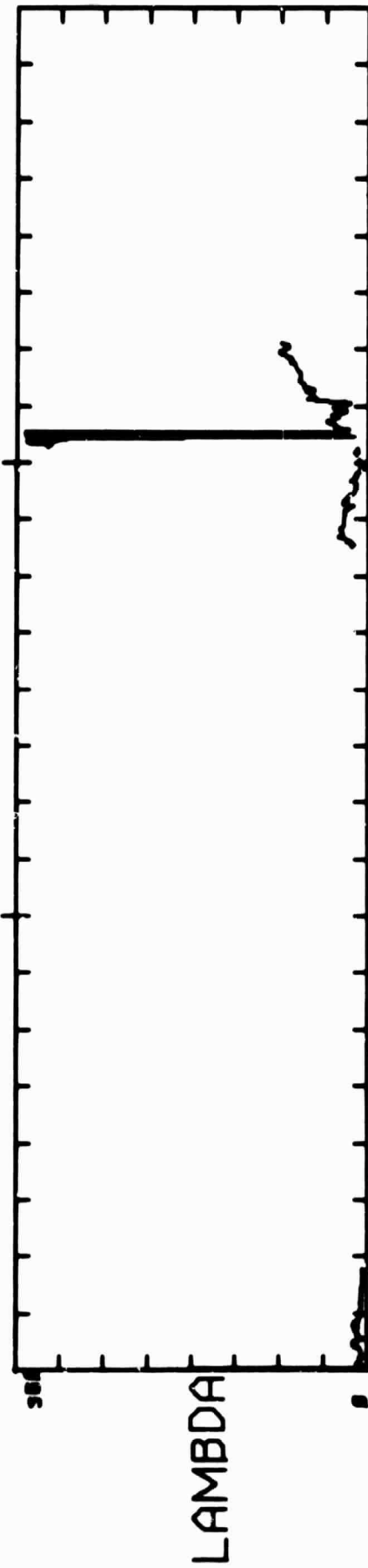
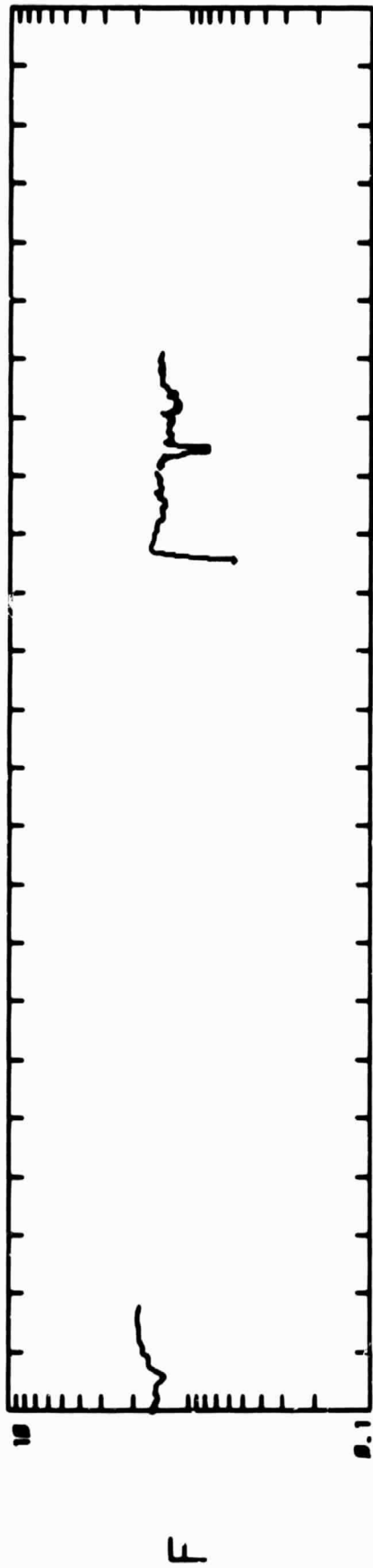
VOYAGER 2



START YEAR +DAY 79 211

30 July

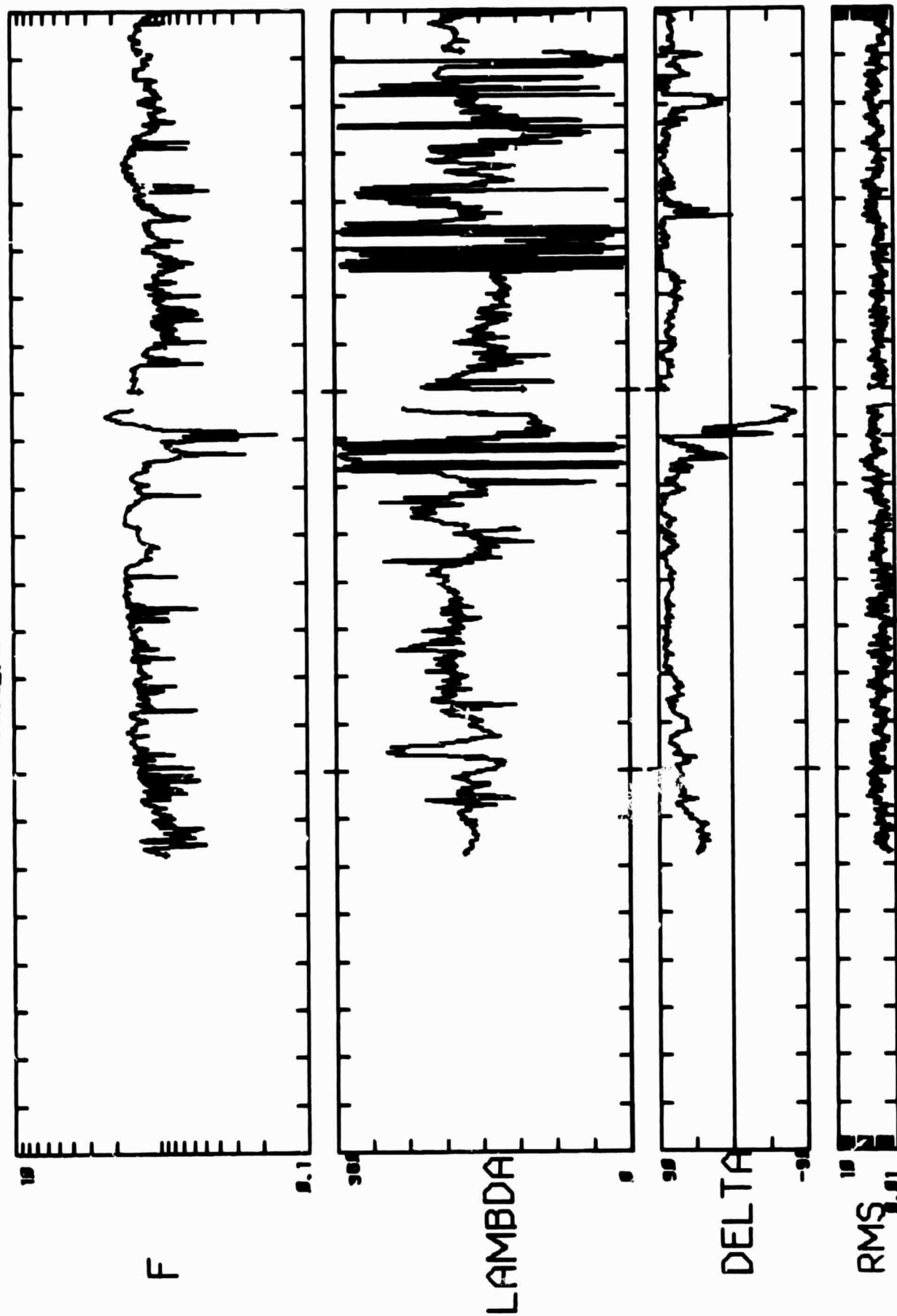
VOTAGER 2



START YEAR +DAY 79 212

31 July

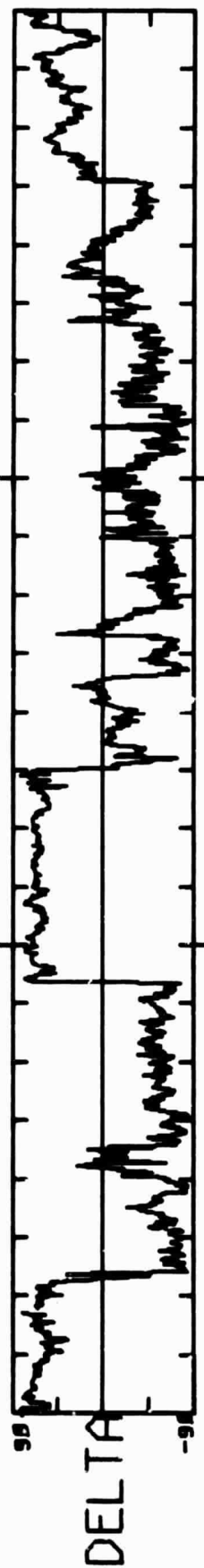
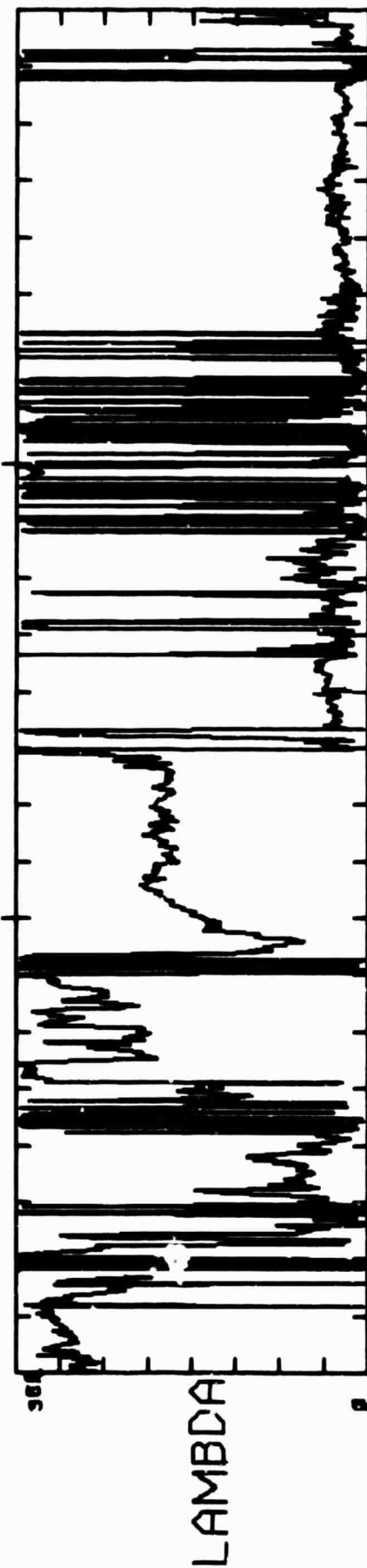
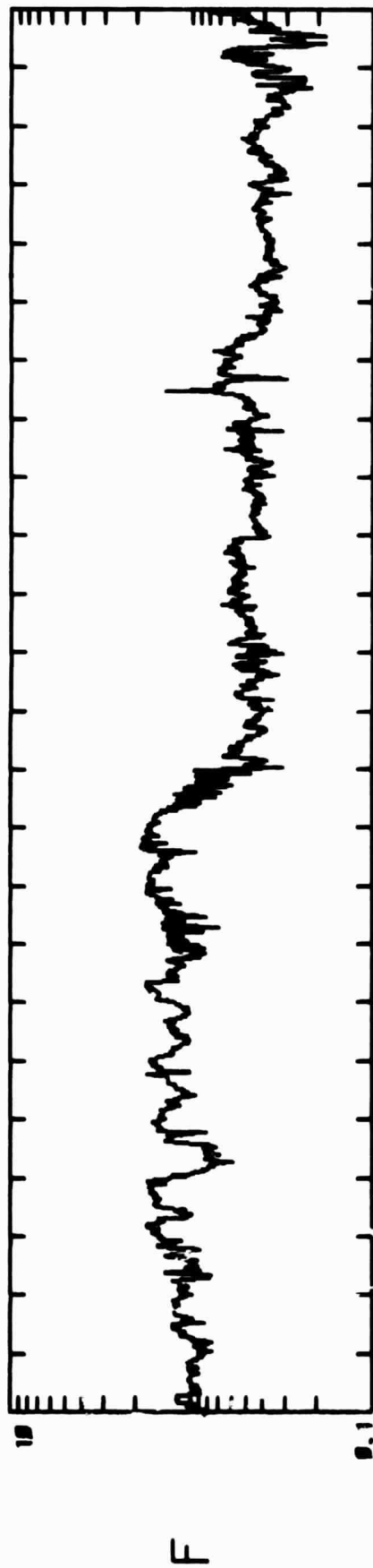
Voyager 2



START YEAR +DAY
79 213

1 August

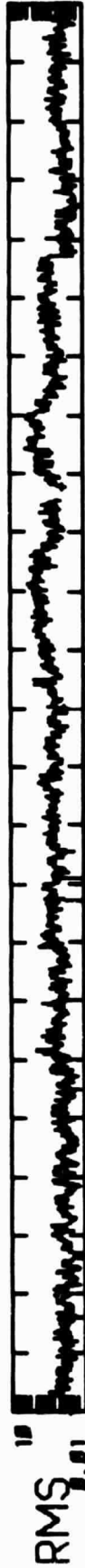
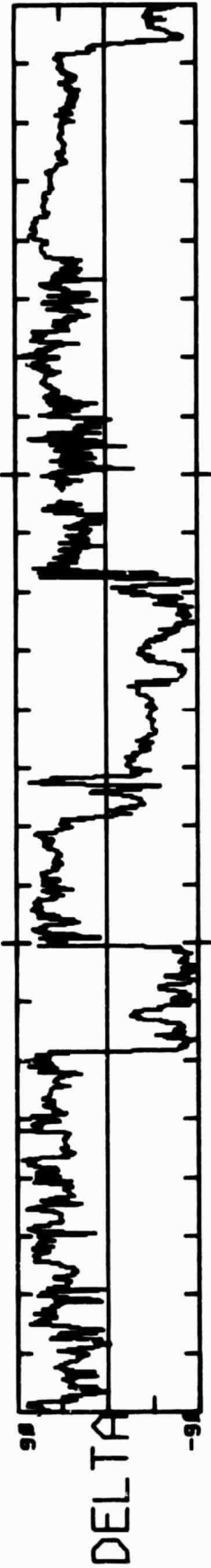
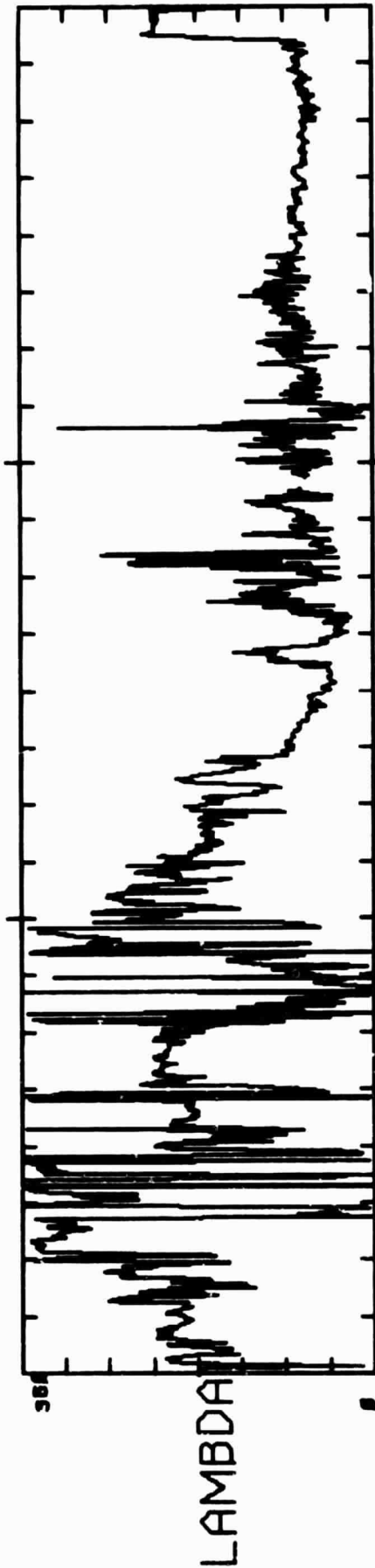
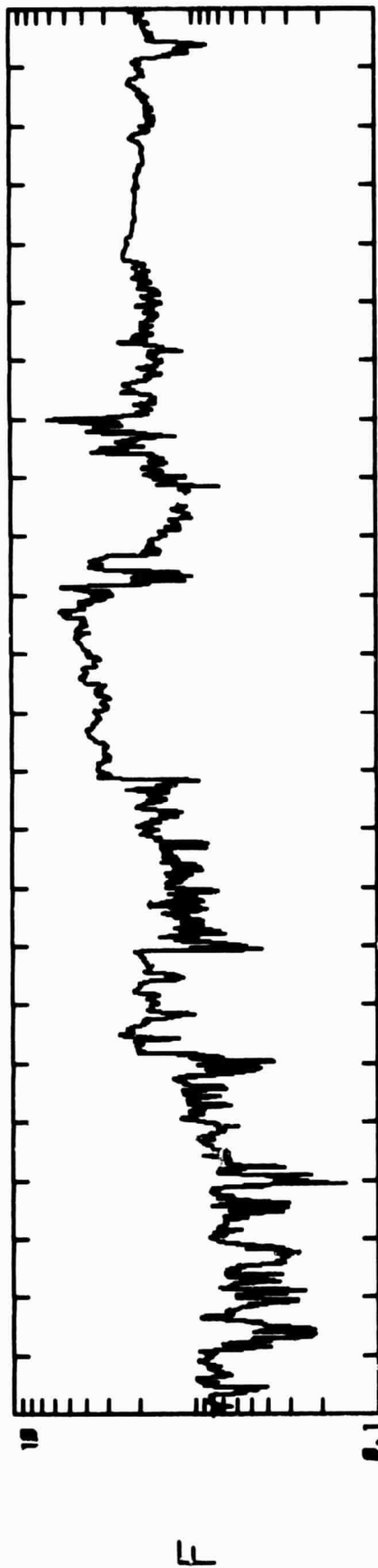
VOYAGER 2



START YEAR +DAY
79 214

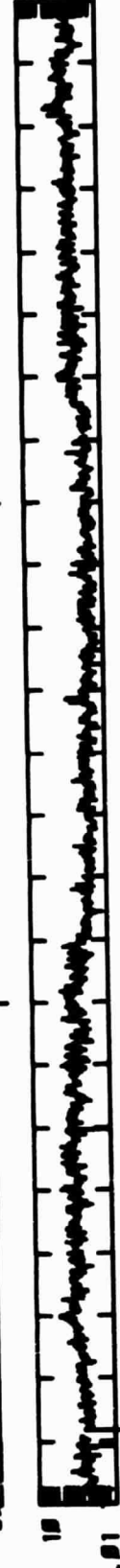
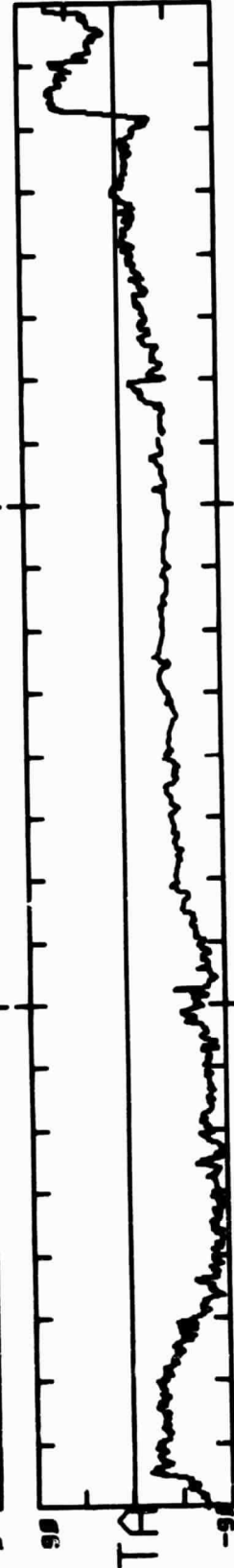
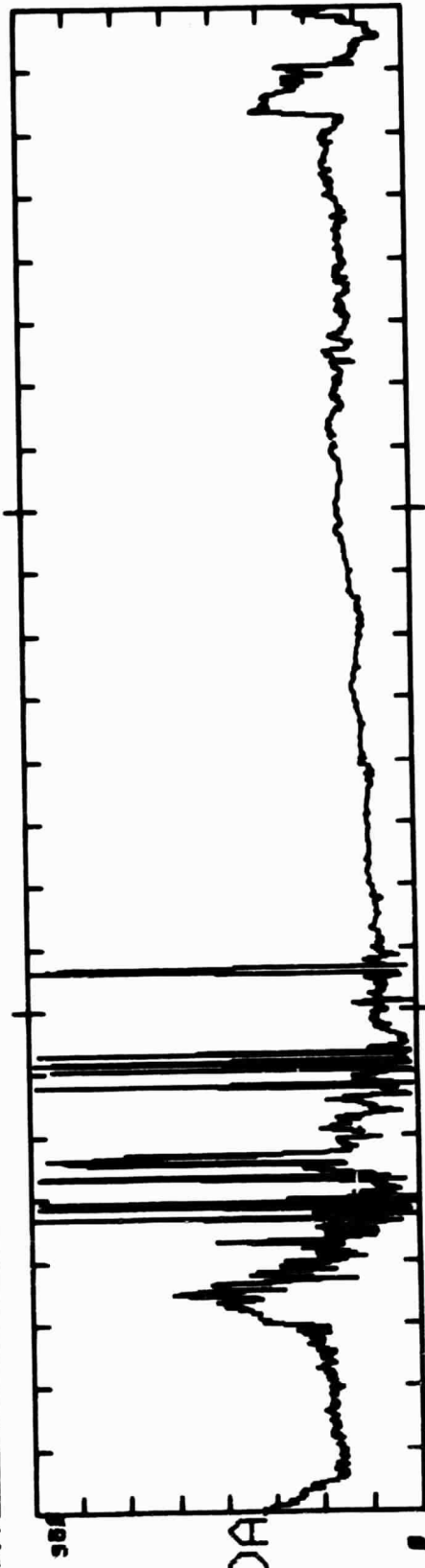
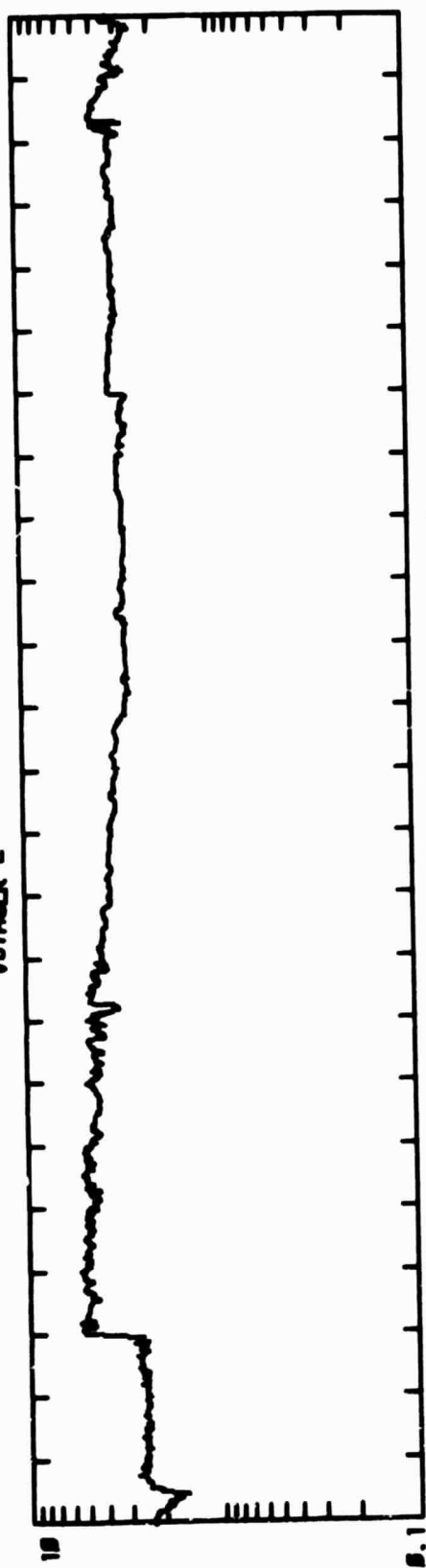
2 August

VOYAGER 2



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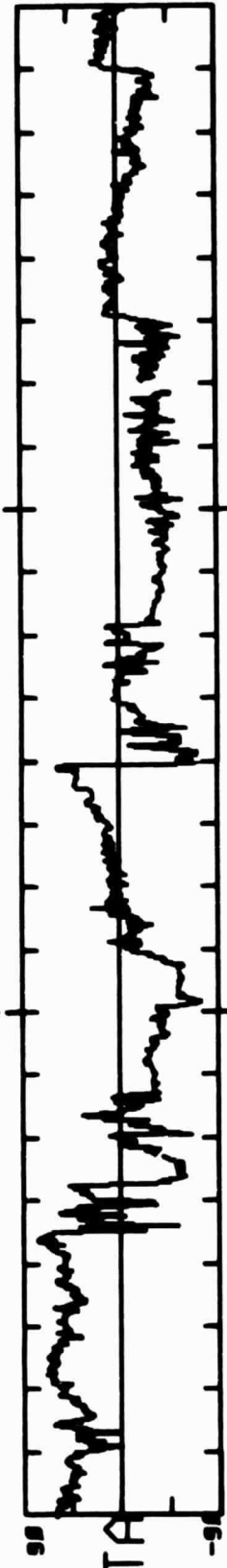
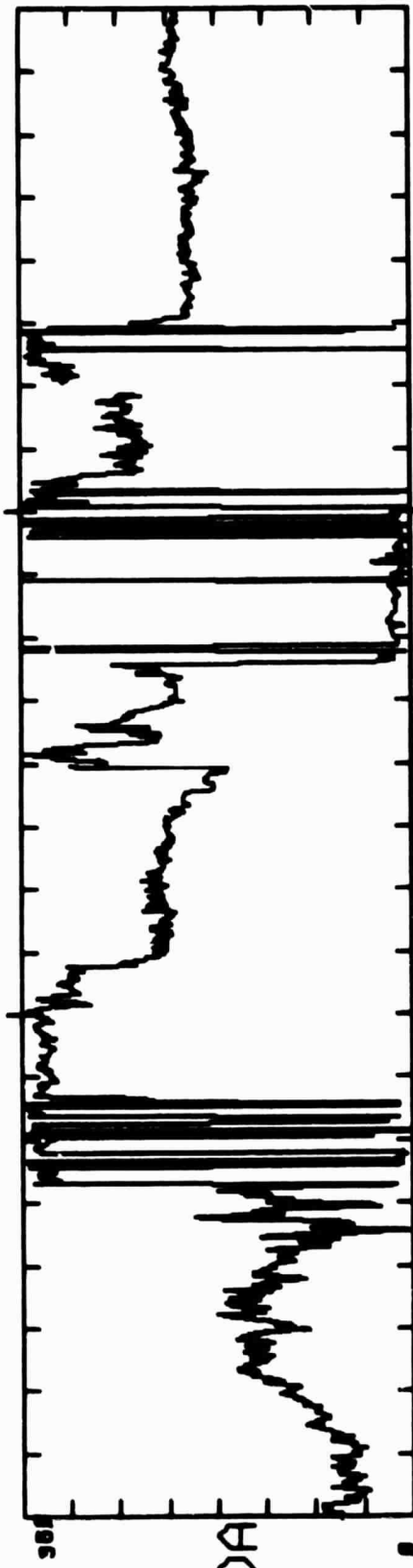
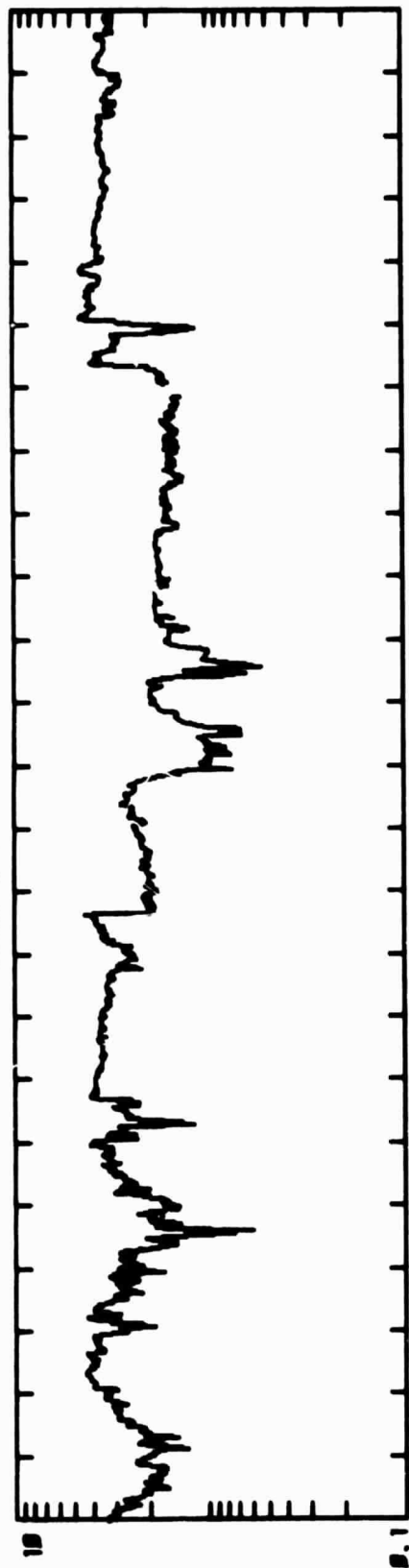
3 August



START YEAR +DAY 79 216

4 August

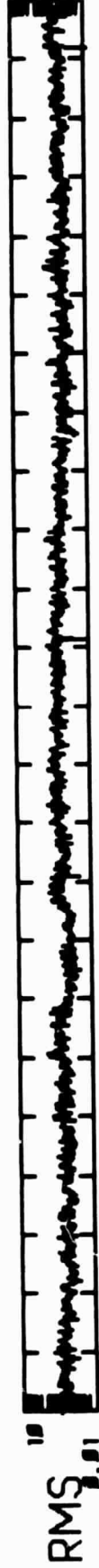
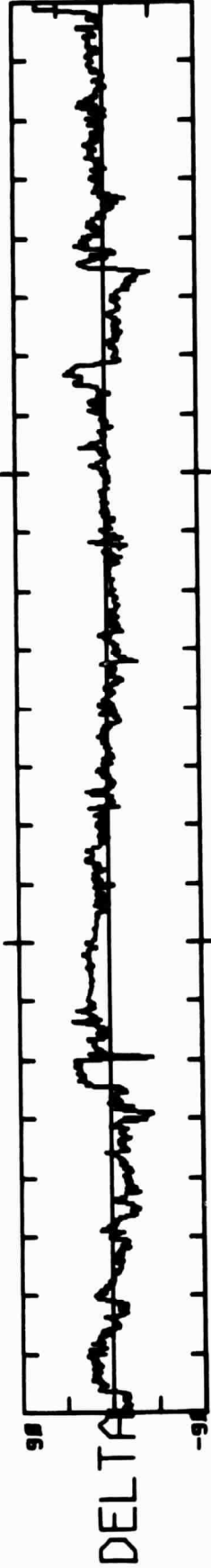
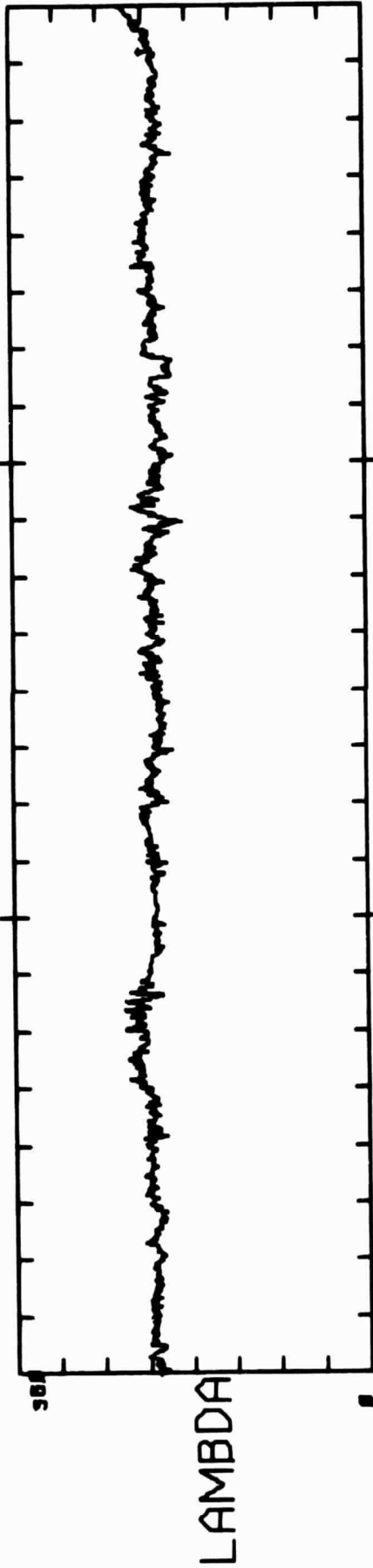
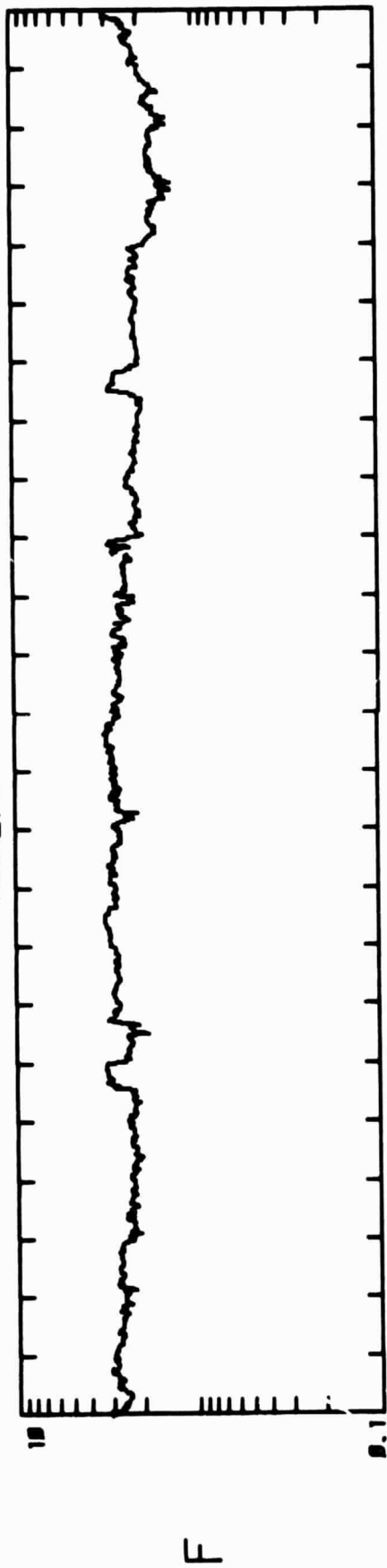
VOYAGER 2



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5 August

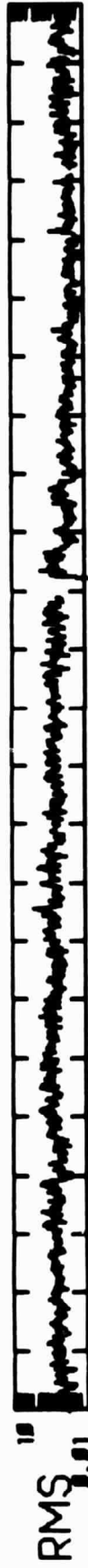
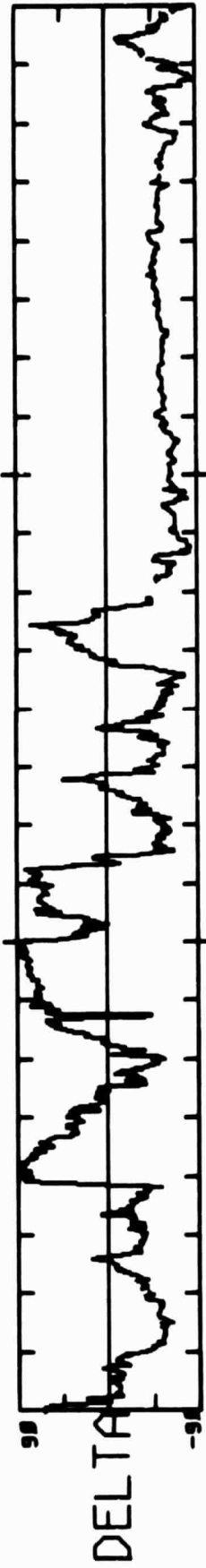
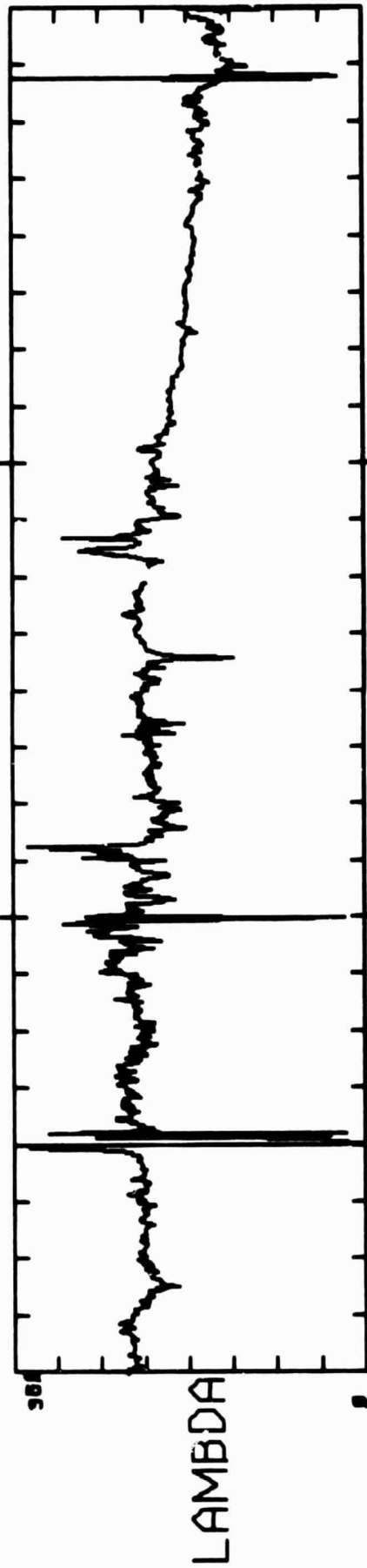
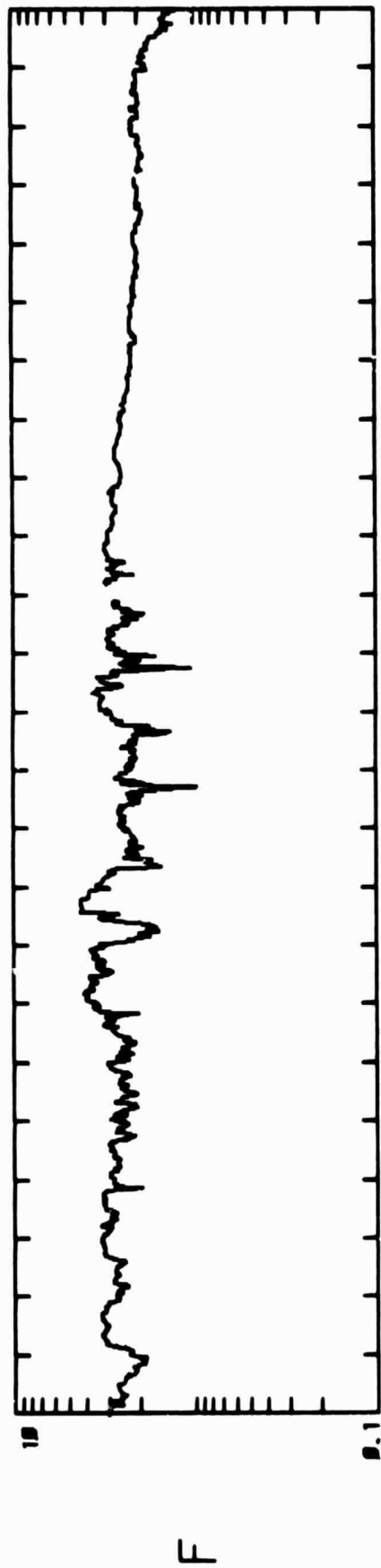
VOYAGER 2



START YEAR +DAY 79 218

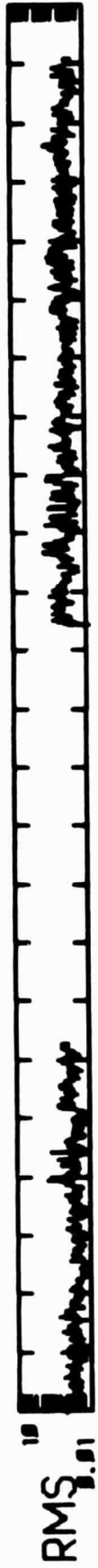
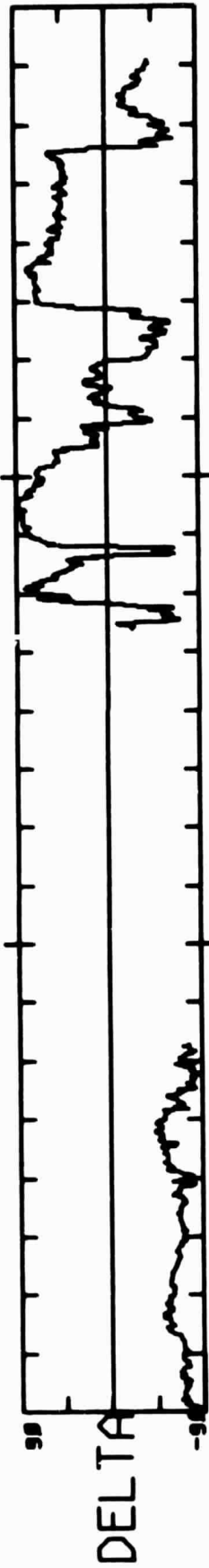
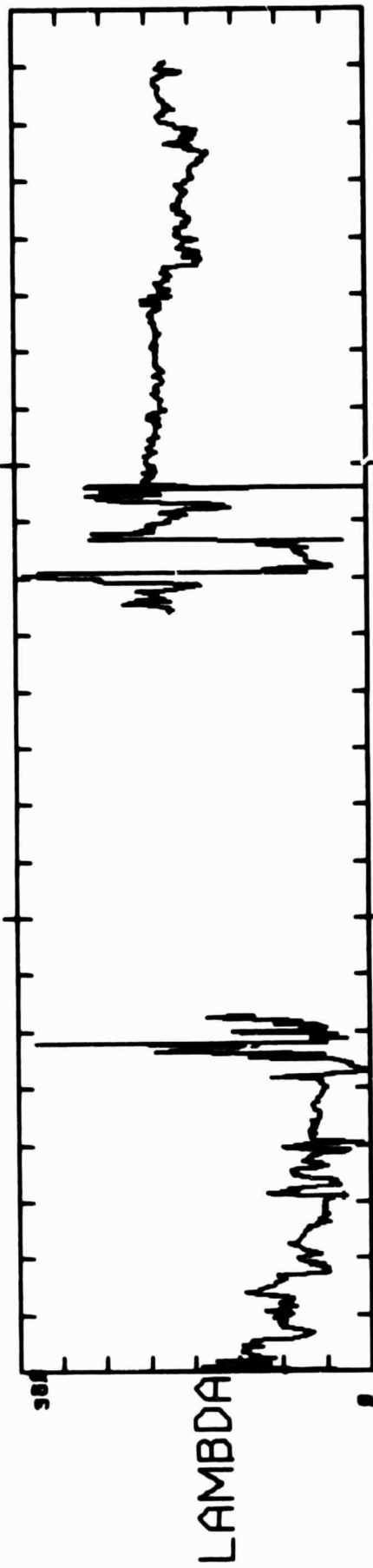
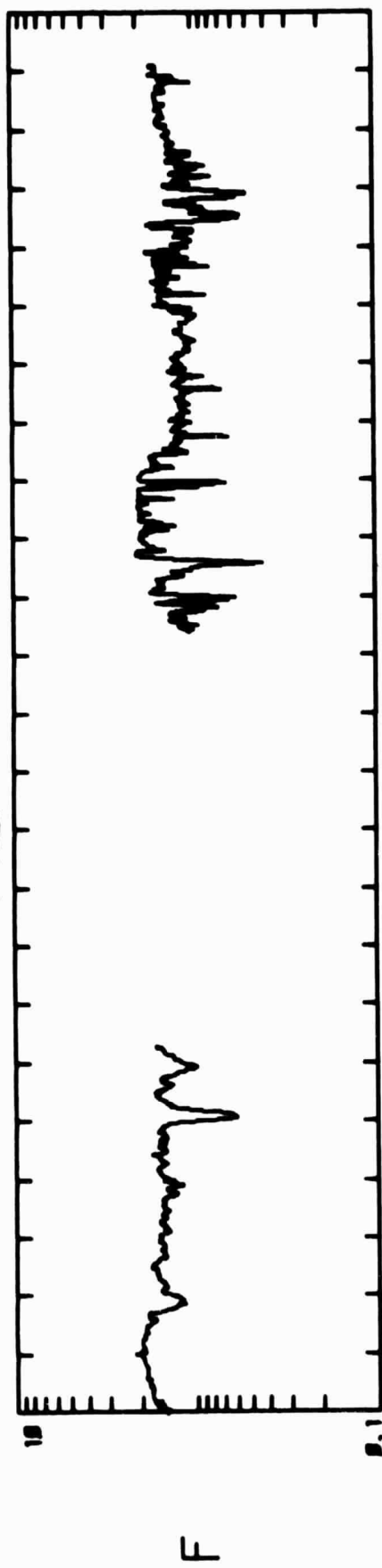
6 August

VOYAGER 2



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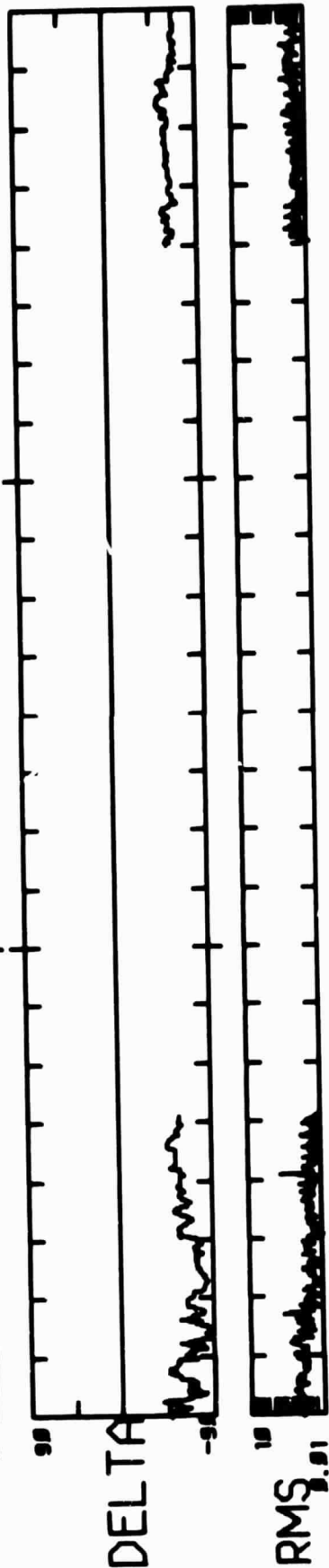
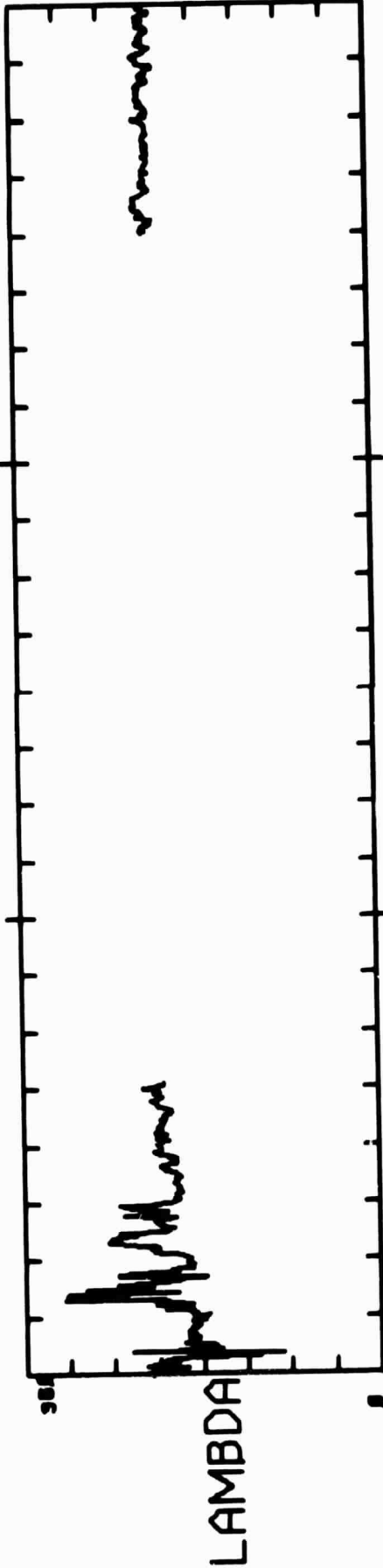
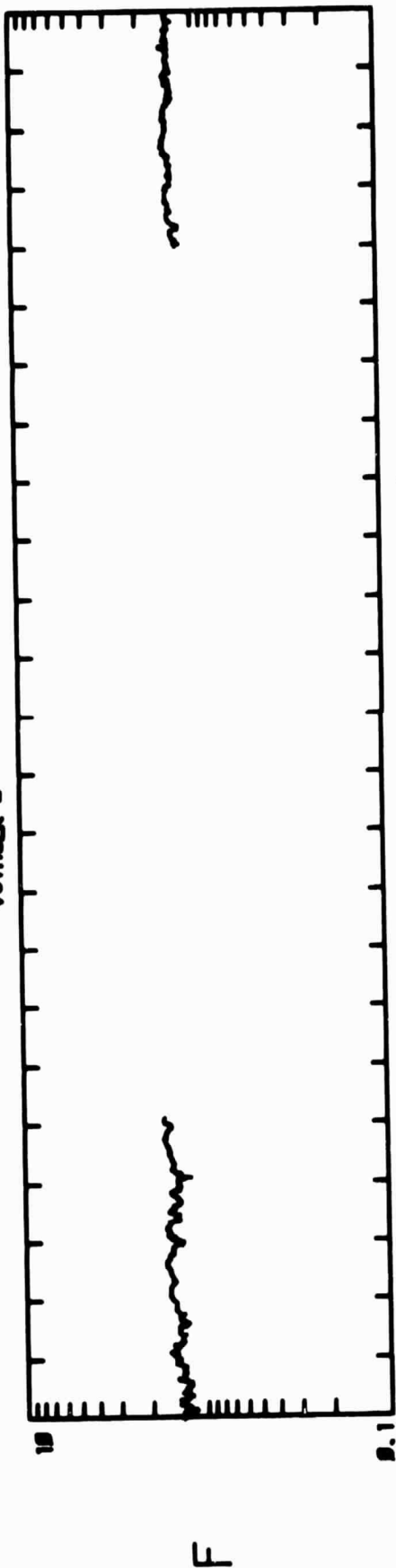
7 August



START YEAR +DAY 79 220

8 August

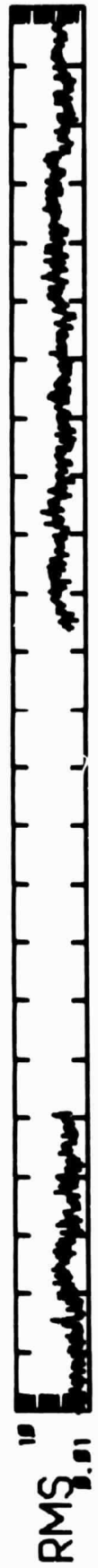
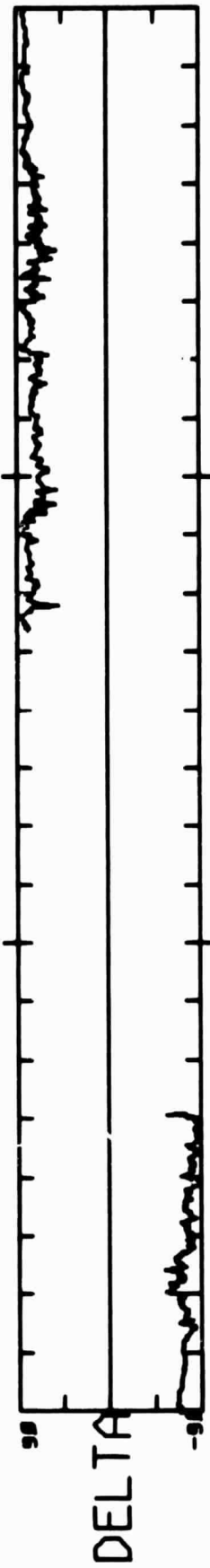
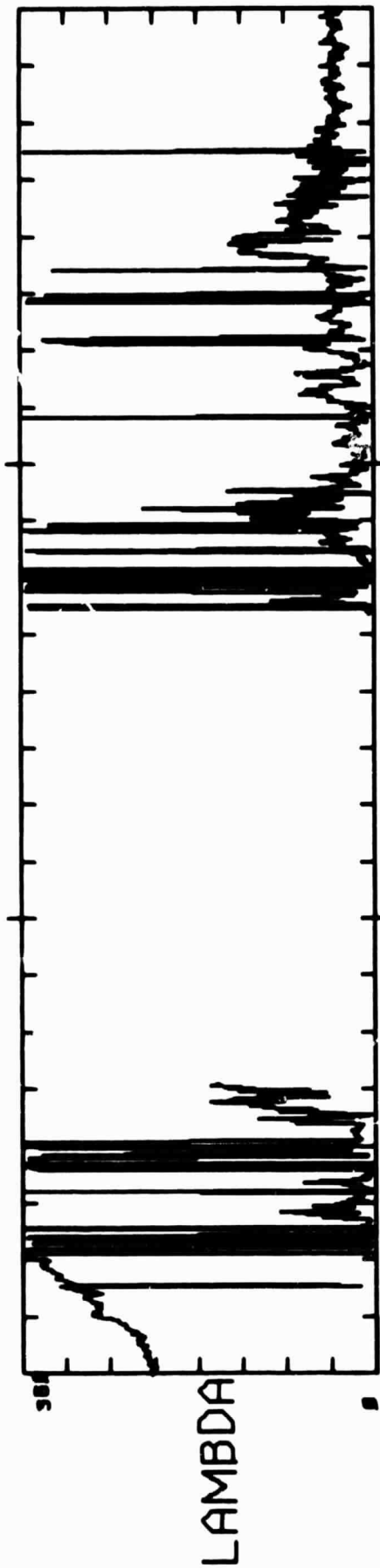
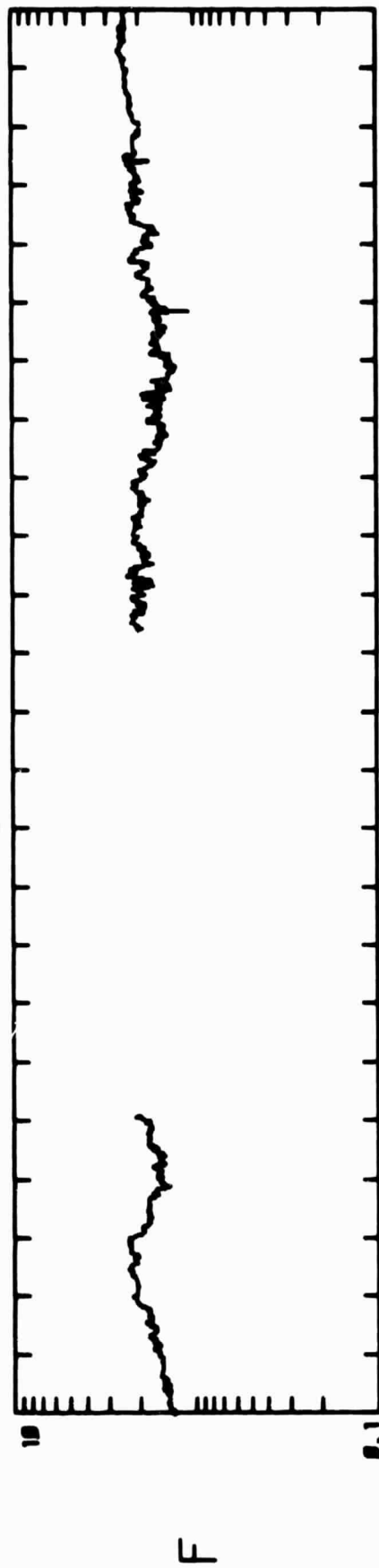
VOYAGER 2



START YEAR +DAY 78 331

9 August

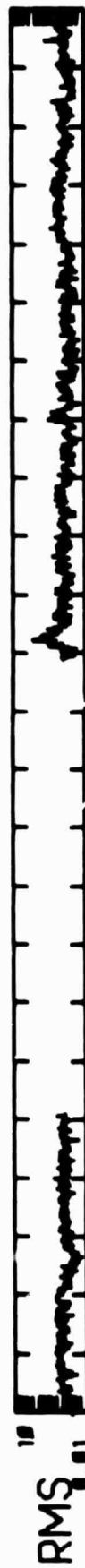
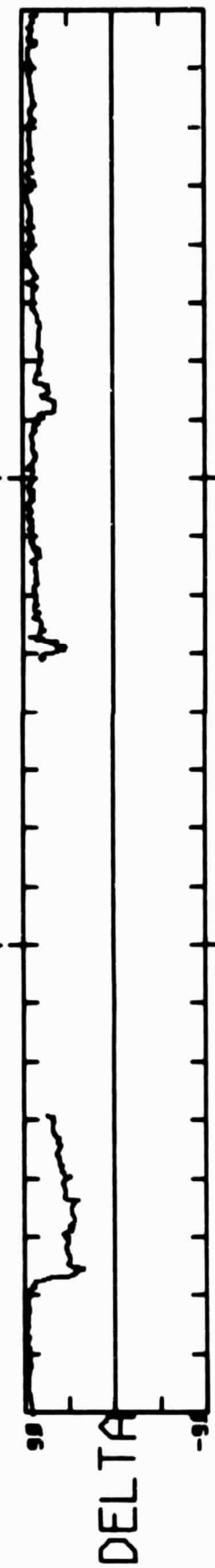
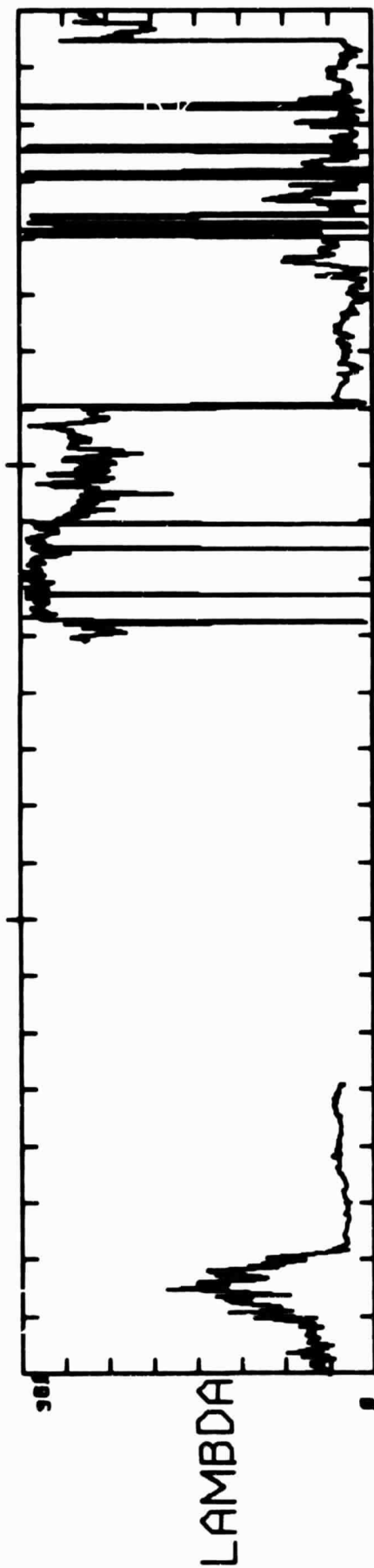
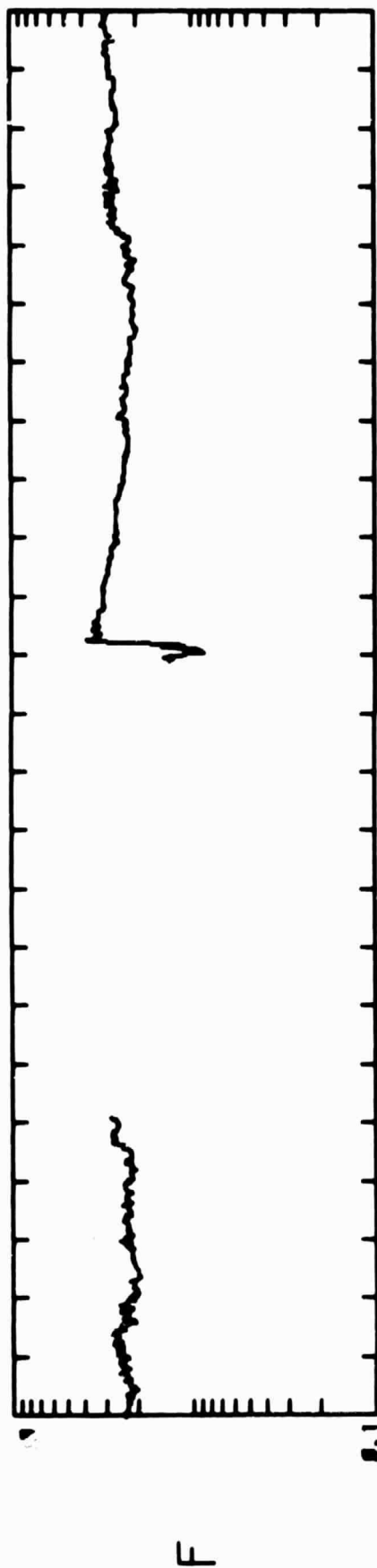
VOYAGER 2



START YEAR +DAY
79 222

10 August

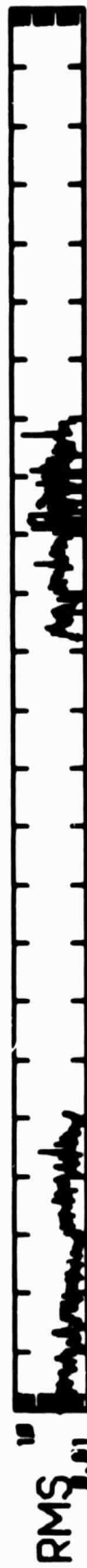
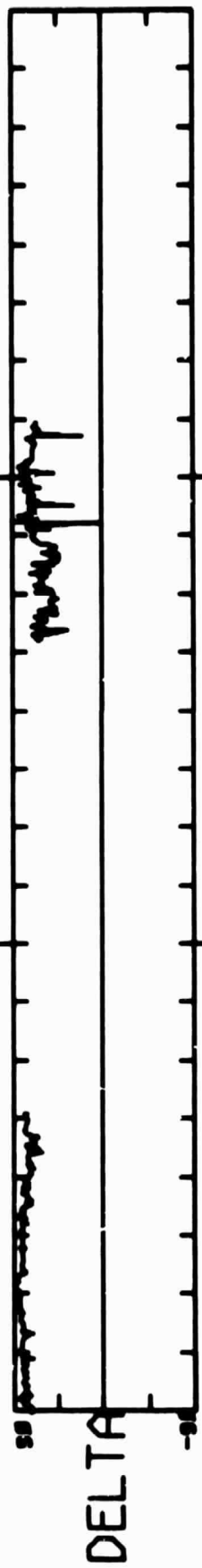
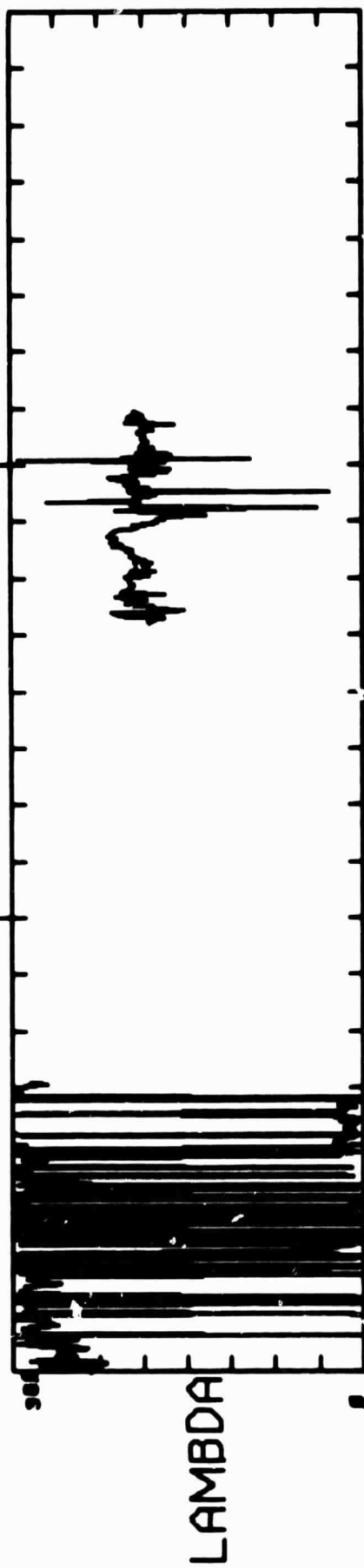
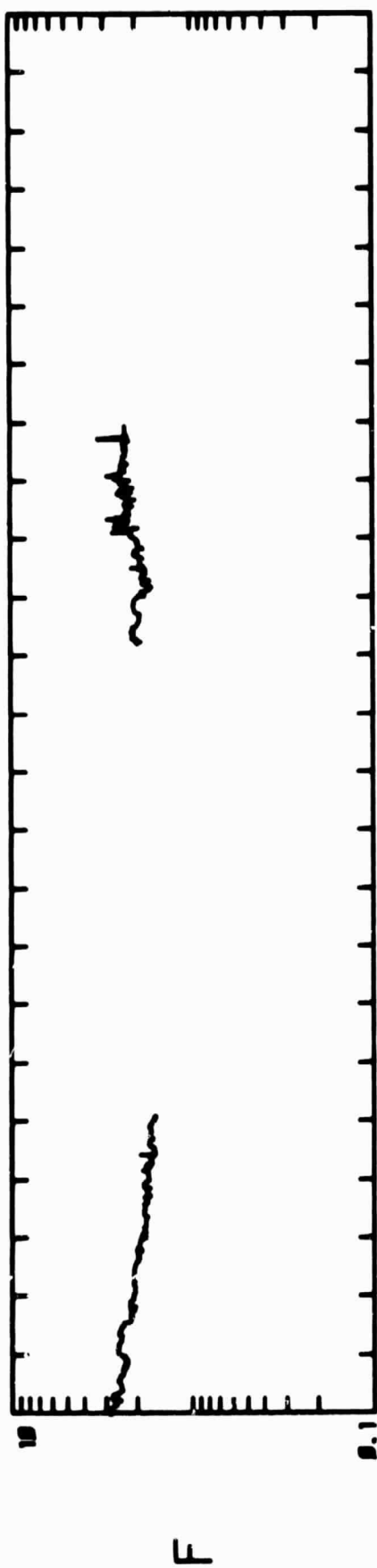
VOYAGER 2



START YEAR +DAY 79 223

11 August

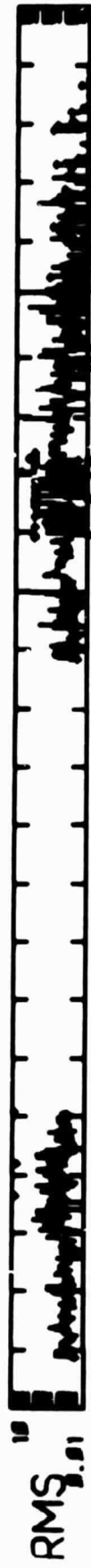
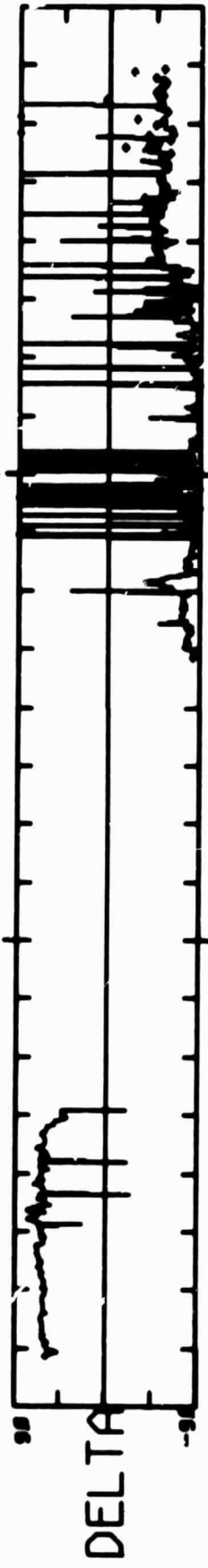
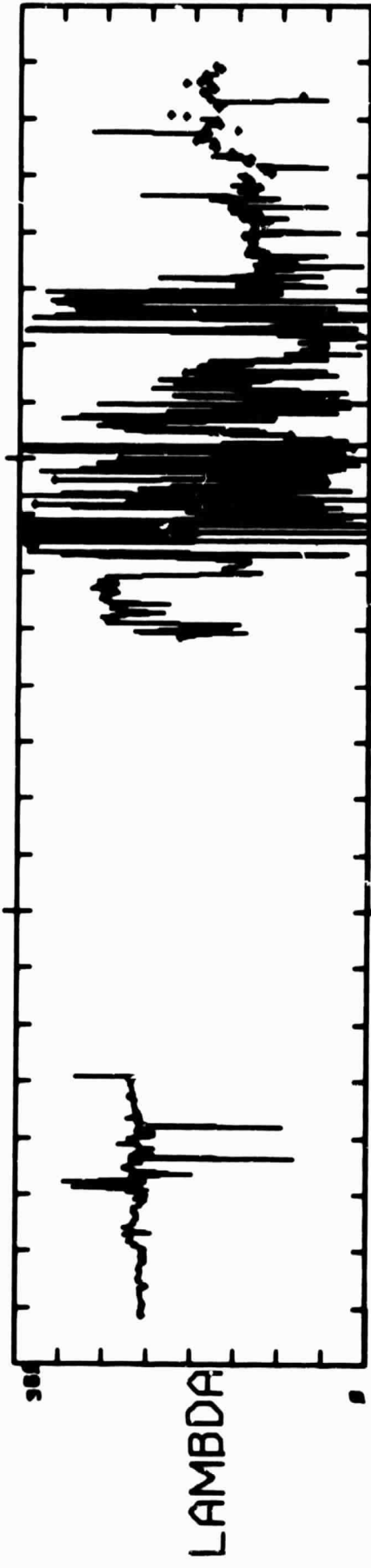
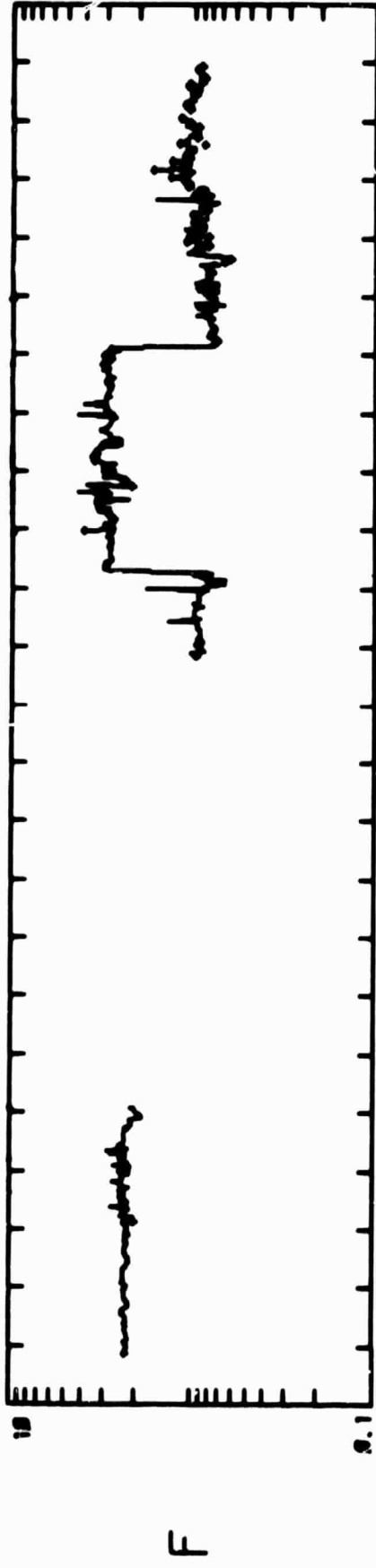
VOYAGER 2



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79 224

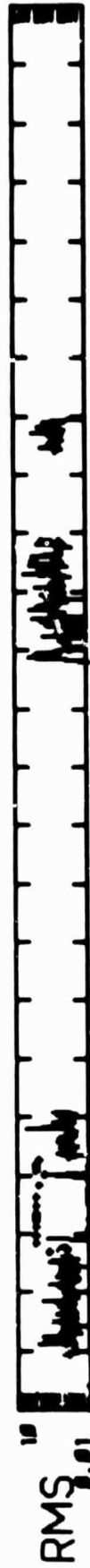
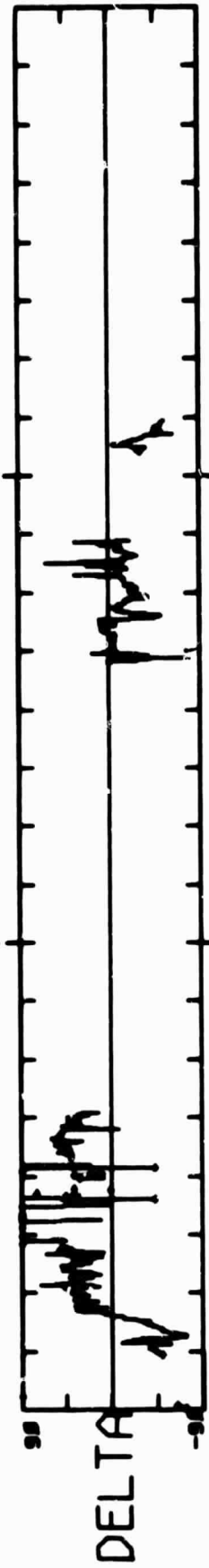
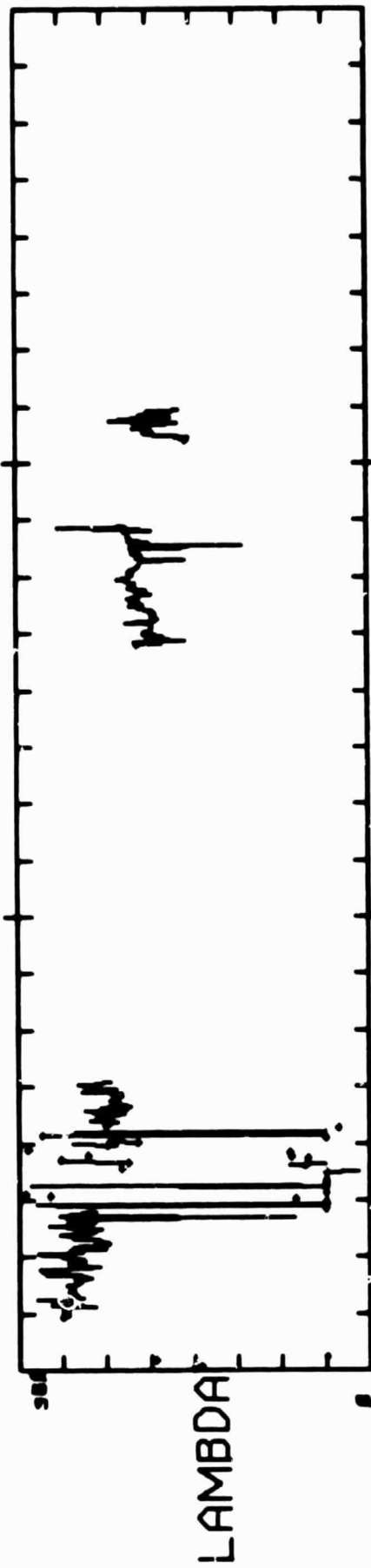
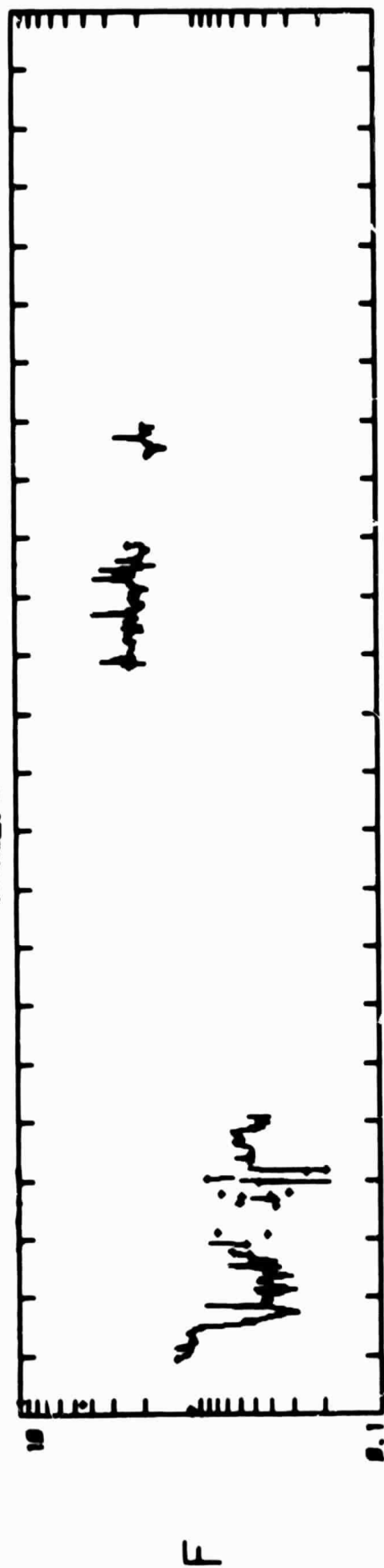
12 August

VOTAGER 2



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13 August



START YEAR +DAY
79 226

14 August